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Comets

The reading public is again becoming comet-conscious. This is the natural consequence of the authentic prediction that in the near future a comet will be visible to the unaided eye. For those whose memories reach as far back as 1910, the year of the best known of all comets, namely Halley's, this prediction presages a spectacle of striking interest. Those who have never seen a conspicuous comet and hence have no basis for judgment may expect too much, and be disappointed, or may expect too little, and be pleasantly surprised. However, the visitation of a comet that is brilliant enough to be easily seen without telescopic aid is an event of such rare occurrence as to be eagerly anticipated by the astronomer and the layman, the educated and the uneducated, the old and the young, alike.

Consider a long-period comet through one complete revolution. Usually it is discovered while approaching the sun. Under the influence of the sun's gravitational pull it moves with greater and greater velocity; stimulated, possibly, by electrical interaction it becomes more and more luminous; this, and the fact that it is coming nearer to the earth cause it to become brighter and brighter. The climax is reached when the comet arrives at perihelion, the point of its orbit which is nearest the sun. After this the effects of the several influences mentioned are reversed. The comet loses speed, loses activity, and loses brightness. Fifty years, or more later it may reach its aphelion point, and again begin a head-long rush toward the sun, coming quite near to it again after one hundred years, or more. The mere contemplation of such a recurring phenomenon is a thrilling mental experience, and accounts, at least in part, for the popular interest in comets.

There is the possibility that some comets never return to the sun. They may acquire so great a velocity at the approach as to carry them beyond the domination of the sun. What becomes of such comets? Here the imagination may begin to operate. Possibly they wander century after century through space. After a long lapse of time they may find themselves under the sway of another star and repeat the circumstances of their visits to the sun, and then go on their way.

Looking in the other direction, their source and previous history afford similar opportunity for conjecture.

That the race has progressed is evidenced by the fact that comets are no longer dreaded as being omens of disaster. They are regarded as phenomena in an orderly system whose laws are universal and immutable.

DECEMBER 15, 1940.

Mars in 1939

By M. GEDDES, M.A., F.R.A.S

The 1939 opposition of Mars was a particularly favorable one for Southern Hemisphere observers and observations were made at the Carter Observatory, Wellington, during July and August whenever the weather conditions were suitable. Actually the first observation was made on June 3 and the last on October 3, but it was only during the few weeks at opposition that the full program was carried out. This consisted in the making of drawings of surface features at half or three-quarter-hour intervals during the night. Three observers participated in this—W. M. Swinburn (16), I. L. Thomsen (14), and M. Geddes (59), the numbers in parenthesis showing the number of drawings made by each. In every case the 9-inch Cooke photo-visual refractor was used, usually with a magnification of 250×. In addition a few micrometer measures were made, chiefly of the diameter of the South Polar Cap. Each disc drawing made at the telescope was later placed on a "light table" and another disc, having on it the orthographic projection of the lines of latitude and longitude, was placed over it. It was then possible to read off directly the position of any feature and to transfer the whole drawing on to a prepared Mercator's Projection chart for subsequent study and incorporation in the map of the entire surface. This method of treatment, due to Thomsen, saved considerable time.

Most of the drawings were secured within a fortnight of the opposition period and, for this reason, the region of the planet from Mare Sirenum to Sinus Sabaeus (long. 150°-360°) was much more thoroughly observed than the rest of the surface. Mention of this brings to light a fact which has not been sufficiently stressed by observers of Mars, that, owing to the almost equal rotation periods of the earth and Mars, from any one observatory it is possible during the period of close approach to observe only a portion of the Martian surface; the remainder of the surface must be observed under less favorable conditions when the planet is more distant. In the present case bad weather also caused a hindrance with the result that the area centered around Solis Lacus was very incompletely observed.

In discussing the observations the names adopted by E. M. Antoniadi[1] have been adhered to. It is not possible, within the limits of this paper, to deal with every marking observed, and remarks have been confined to points considered of interest, either to other observers or in relation to past oppositions. For this reason no mention is made of the majority of the canal markings—those which were seen with any certainty are shown in the accompanying map (Figure 5).

The South Polar Cap. The observations covered too short a period for detailed records of the melting of the South Polar Cap, but, even in

the brief time that it was studied, there could be no doubt that it was melting very rapidly. The dark border round the cap proved to be very variable in visibility, but most of the changes could be accounted for by the influence of the surrounding markings, such as Depressiones Hellesponticae. On a number of occasions there was evidence of an obscuring veil, possibly of mist, as portions of the cap varied greatly in intensity. This was particularly the case after opposition when bright spots and dull patches were much in evidence. This is consistent with what we should expect from a rapidly melting cap.

The North Polar Cap. A white marking was seen regularly in the northern region, very similar at times to the South Polar Cap, but usually much more irregular and duller in color. Theoretically no trace should have been seen of a cap here, and there seems every reason to believe that it was not a true cap. It was visible at various times in all longitudes. In general it was duller than the South Polar Cap, but on July 25 at $11^h\ 35^m$ U.T. ($\omega = 277°$) it was much more prominent than the latter, shining with an intense bluish white light. Its southern limit varied but lay usually in from 50° to 65° north latitude. At times this south border was very irregular and it appeared to undergo slight changes from night to night. Considering these facts in conjunction with the state of the Martian seasons, the only conclusion possible is that it consisted of mist or cloud. Its nature was certainly totally different from that of the true polar cap in the south.

Mare Acidalium Region. The division between Mare Acidalium and Niliacus Lacus—Achillis Pons—was seen plainly only once, on August 13, although it was suspected on some other nights.

GEDDES THOMSEN

FIGURE 1
MARE ACIDALIUM REGION ON JULY 10

The most interesting feature of this region, however, was the dark marking seen on July 8 by Geddes and on July 10 by Thomsen and Geddes. It was not recorded at any other time during the opposition. From the three or four drawings available its position seems to have been approximately Lat. +40°-+50°, Long. 50°. On both nights it was very prominent and was distinctly separated from Mare Acidalium. (Figure 1). A photograph of this area taken by Jeffers and Miss Adams at the Lick Observatory on August 11 ($\omega = 48°$) and reproduced in the *Publications of the Astronomical Society of the Pacific*[2]

shows a prominent dark marking in this position. This is of particular interest because no trace of the feature was seen at Wellington on August 13 or on any subsequent date. Antoniadi's Acidalius Fretum is somewhere near here, but the only record the writer can find of an actual comparable observation is on the Lick map of the 1924 opposition,[3] where an extensive shaded region is shown 10°-15° W of Mare Acidalium and extending between latitudes +50° and +30° with an oasis in latitude +34°, longitude 55°.

Mare Erythraeum Area. Very little detail was seen in this area during July. Pyrrhae Regio, for instance, which had been seen faintly on June 3, was, except for the bright region of Eos, totally invisible. Apart from Oxia Palus, which was faintly visible at the northern end, Margaritifer Sinus, although very obvious, was completely featureless, shading gradually into Mare Erythraeum. When the area was again visible in the middle of August, however, a remarkable change had taken place

JULY AUGUST

FIGURE 2

CHANGES IN NEIGHBORHOOD OF MARGARITIFER SINUS

(see Figure 2). Pyrrhae Regio was easily observable, with Eos extending well down into it, while Margaritifer Sinus had a conspicuously dark region near its center and had extended in a series of two or three clots along the Oxus, so much so that the latter appeared to be an integral portion of the main marking. This extension was not directly towards Niliacus Lacus, but towards a point some degrees to the east of it.

Iuventae Fons. This was very obvious as a tiny black dot on July 10 and was faintly visible on July 14. At no other time during the opposition could any trace of it be observed, although there is some suspicion of it on the Lick photograph already mentioned.

Solis Lacus Area. During the first period of visibility of this region (until July 14) Agathodaemon was very dark and prominent, running

for some distance into Aurorae Sinus, but it was much fainter in August. The fact that this marking and Iuventae Fons were both prominent about the same time seems to be significant. At least three main divisions could, on most nights, be traced in Tithonius Lacus. Faint shading separated it from Solis Lacus, but no connecting canals were seen.

Solis Lacus itself had much the same appearance as in 1924, possessing three, and possibly four, dark regions. On nearly every occasion that it was seen it gave the impression of having immense detail just beyond the limit of vision. On July 14 it had a brownish tinge, contrasting with the greenish hue of the neighboring maria. Nectar did not appear to join up with Aurorae Sinus.

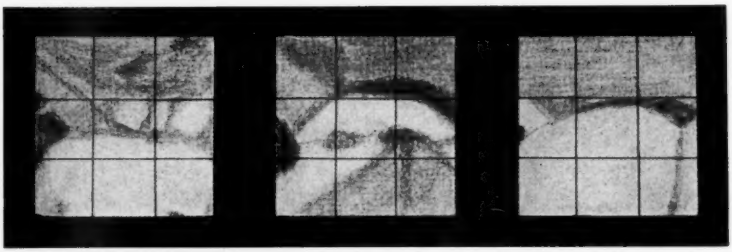
No detail could be seen in Thaumasia, or in the areas immediately to the east of it. Ambrosia was seen faintly on July 14 and August 10.

Phoenicis Lacus was joined by canals to all the neighboring markings —Eosphoros, Nox, Iris, Araxes, and an eastward extension of Eumenides being recognizable. It was not a prominent marking, however.

Mare Sirenum Area. Much more detail than shown on the map was always suspected here. The more lightly shaded central region defied all attempts to determine its exact nature and shape. The only features which could be determined with any certainty were the dark areas on the north and west. In the north, except where the network of canals radiated from Titanum Sinus, there was a sharp line of demarcation between the Mare and the light region of Memnonia. The latter was one of the lightest regions on the planet, almost comparable with Edom Promontorium. In the south the mare shaded rather indefinitely into Phaethontis and Electris, with the rather uncertain line of Atlantis cutting across towards Icaria.

As for the continents to the north, Amazonis was rather heavily shaded, but detail in it was uncertain. It was very much darker than the more northern Arcadia, the two being always quite distinct from each other.

Laestrygonum Sinus. This was another difficult marking to define. It appeared to be in two sections, the combined marking being very different from the form shown by Antoniadi and the B.A.A. observers at past oppositions. At times it appeared to be connected at each end to Mare Sirenum and Mare Cimmerium, but at others it appeared entirely detached. If there was a connection it was very faint. To the south Symplegades Insulae separated it very definitely from Mare Cimmerium. This appears to be supported by a Lick photograph of July 27[2] although it would be necessary to examine the original negative to be sure of this. This separation does not seem to have been nearly so prominent at other oppositions when Laestrygonum Sinus has usually appeared merely as a bay of the Mare Cimmerium. Maggini in 1924[4] and the B.A.A. observers in 1935[5] show it well separated, however. Figure 3 contrasts the appearance of this region at the present opposition with that shown on



ANTONIADI 1939 USUAL

FIGURE 3
LAESTRYGONUM SINUS REGION

Antoniadi's map[1] and at most other oppositions. Whether the variations are due to real change or to observational differences is difficult to say. The marking was usually comparable in darkness with the surrounding maria.

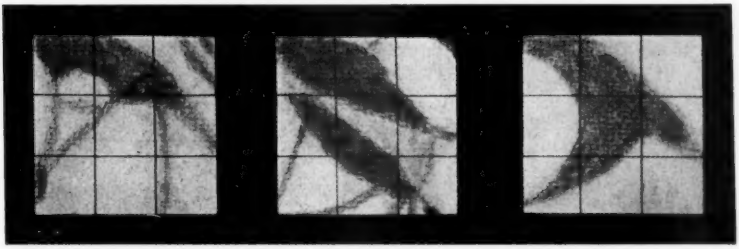
Trivium Charontis. This lake was one of the most prominent features on the planet, and with its radiating network of canals it formed one of the most interesting areas. It varied somewhat in intensity but was usually very dark, appearing at times to be broken into two sections. Pambotis Lacus to the west was sometimes merged into it; in fact the connecting canal, Cerberus I, was more in the nature of an outer penumbral region of Trivium Charontis. The two canals to the north of it, Hades and Styx, were very prominent, forming a wide dark marking, evident at a glance and rivalling in intensity the broad streak of Nepenthes-Thoth. Except for Orcus, which was really on the border of Amazonis, and Cerberus II (mentioned below), the other canals of the region were faint.

Elysium was not the prominent light area which it appears to have been at some previous oppositions. In fact it was not realized that it had been recorded until the surrounding canals were drawn in on the map and its true form appeared.

Mare Cimmerium. The change in this marking was the most remarkable feature of the opposition. The region was not seen near the central meridian until July 25, when it was at once noticed by all three observers that the Mare Cimmerium appeared to have split at its northern end and now possessed twin points. Observation on subsequent nights showed that the new marking was separated from the main mare by an isthmus, broad and lightly shaded to the northwest, but very narrow and difficult to define at the southeast end. Figure 4 contrasts this appearance of the Mare Cimmerium with that usually recorded. The Lick photograph of July 27, already mentioned, shows the feature fairly distinctively. On July 29 it was the darkest marking visible in this hemisphere of the

planet and stood out boldly, clearly separated from Mare Cimmerium. On other nights the dividing isthmus was not quite so certain, except to the northwest.

A remarkable feature was the manner in which the various canals, such as Aethiops and Triton, which previously radiated from the tip of Mare Cimmerium, now came from the tip of the new marking. This is shown very distinctly on all the drawings, and any explanation of the development of the marking must also explain this alteration in the canal system. A reference in *Sky*[6] to vast changes in the Bay of Cyclops region seems to indicate that the changes were also observed by Slipher in South Africa.



NORMAL 1939 1800

FIGURE 4

CHANGES IN THE MARE CIMMERIUM REGION

In the case of Mare Cimmerium itself there was a considerable difference between the NE and SW shores. The latter, along Hesperia, was clear and definite, but the former was hazy and appeared to possess a kind of penumbral region. On August 5 the whole mare had a clotted appearance.

Cerberus II was generally the most prominent of the canals radiating from the Mare Cimmerium area. It disappeared completely, however, on August 2, was visible again on August 4, but was not recorded on August 5. Cloud may possibly have been responsible.

The general shape of Hesperia was much as in the past. It was fairly heavily shaded with a canal across the northern end and a less definite one across the southern. There was also the appearance of a canal across the middle of it, probably Hyria Lacus. In the region of this last there were definite bays in Mare Cimmerium and Mare Tyrrhenum.

Mare Tyrrhenum, Ausonia, and Hellas. Mare Tyrrhenum was very dark, much more so than Syrtis Major. To the south, between Hesperia and Ausonia, it had a clotted appearance giving it a very irregular border. Syrtis Minor was quite distinct and did not appear to be a component part of the mare, although the only separation consisted of a slight lightening of the shading.

Ausonia was noticeable for the persistent white region in about latitude —30° to —40°. This defied all attempts to determine its exact position, size, and form, although at times, notably on July 27, it was very prominent. It is depicted on the map, therefore, in a very conventional form. From night to night its general brightness fluctuated very considerably. Ausonia, itself, was the brightest and plainest of all the southern islands and seldom had the veiled appearance of Hellas, Argure, etc.

Hellas was not a prominent marking and for a period between July 23 and the middle of August it was very difficult to observe. There appeared to be a veil over it and frequently only a small portion of the northern border could be defined. At all times the southern half was heavily shaded, comparable in fact with Hellespontus which appeared to merge into it, and the southern border was never seen. When other portions of the border were observed they were quite irregular. By September the obscuring veil appeared to be clearing, for on September 1 the northern portion was bright and very red. Farther south the veil had not lifted, however, except for a narrow strip along the western edge.

Syrtis Major Area. The Syrtis itself, while suspected at times of having a clotted appearance, possessed very much its usual form. It was always very dark and obvious, and on most nights there was visible a small lake, separated from the northern tip by a narrow band of shading. Presumably this was Nili Lacus, and from it there radiated two hazy canals, neither in the least resembling the prominent Nilosyrtis recorded at some previous oppositions. To the south the gulf was separated from Mare Tyrrhenum and other markings by a more lightly shaded band which ran round from Libya to Deltoton Sinus where an extension of the latter cut it off from Aeria. Under poor seeing conditions the Syrtis extended southwards to obscure the whole of this region.

Moeris Lacus was comparatively small and narrow, although always very prominent. Two canals ran south from it, one due south to Mare Tyrrhenum forming the border of the lightly shaded Libya, and the other southeast to Syrtis Minor. There was no trace of a connecting link with Mare Cimmerium.

The Nepenthes-Thoth-Casius system was the most prominent of all the canals—a broad dark streak running due north, becoming much darker and broader when Casius was reached. It bore very little resemblance, however, to its appearance in 1909 and 1911, although it was apparently plainer than at some more recent oppositions. Generally speaking it was just as easily seen as any of the neighboring maria.

Sinus Sabaeus. There was little worthy of note here except that the feature was always very dark, probably the darkest region of Mars. Aryn was not constantly visible, but, when looked for, could usually be seen. During August Edom Promontorium was the brightest feature on the planet, standing out very sharply and clearly.

Pandorae Fretum. Slipher[6] has reported that this marking was not recorded on his photographs and was apparently completely absent during the opposition. This was certainly the case during most of the period, but on August 20 it was easily seen. At times previous to this, notably July 25, a faint suspicion of it was observed. It was again plainly visible on August 22 and 24 (the last date on which this portion of the planet was observed) so that it appears that we are here faced with the temporary disappearance and subsequent reappearance of a marking.

Variations in the visibility of this strait have been recorded on numerous occasions in the past so that it seems possible that it may pass through a regular series of changes.

Argyre Region. Detail in these southern regions was always very poor and the outlines shown on the map must be taken merely as approximations. The only definite feature of this region was the dark mass of Depressiones Hellesponticae. It seems possible that this portion of the planet may have been heavily veiled by cloud during the opposition as the markings should otherwise have stood out much more plainly.

The Canals. To compare the appearance of any individual canal with that shown by it at a previous opposition is an almost impossible task, for no two observers seem to be able to agree with regard either to what

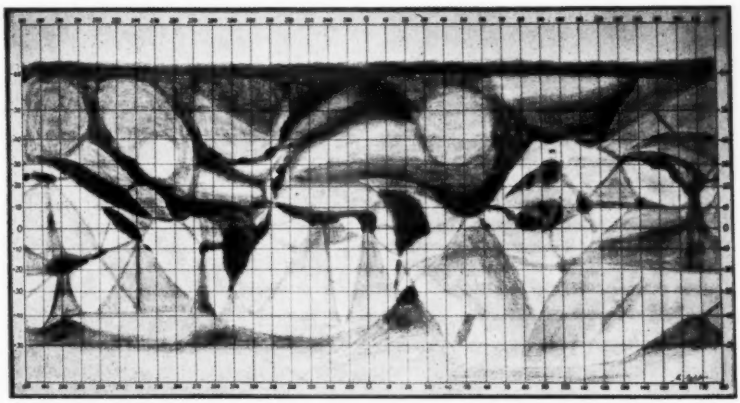


FIGURE 5
MARS IN 1939

they see or to the method of representing it. These remarks do not apply of course to such obvious features as Nepenthes-Thoth, Cerberus, etc., where "canal" is a misnomer. The canals seen with any certainty are shown on the map (Figure 5) and no useful purpose can be served by discussing them more fully.

The general conclusion formed by the writer was that most canals were merely divisions between areas of unequal shading. While they

were thus essentially real surface features they could also be described as an optical effect in that they existed only by virtue of the surrounding markings. Exceptions to this were Agathodaemon, Styx and Hades, Cerberus, and the Moeris Lacus-Nepenthes-Thoth-Casius system, all of which are really too broad and prominent for classification as canals.

White Regions on the Limb or Terminator. These were seen quite frequently. The following table shows those which were recorded. Column 1 gives the date; colume 2, the longitude of the central meridian at the time; column 3, the approximate region over which the white patch appeared; column 4, an indication of whether it was a sunrise (W) or sunset (E) effect.

Date	ω	Region	Limb or Terminator
June 30	149°	Aeolis	W
July 10	38	Edom	W
14	35	Edom	W
27	309	Mare Erythraeum	W
		Mare Cimmerium	E
28	191	Phoenicis Lacus	E
	199	Memnonia	E
29	229	Syrtis Major	W
	247	Aeria	W
Aug. 2	201	Phoenicis Lacus	E
	226	Syrtis Major	W
3	178	Tithonius Lacus	E
		Mare Tyrrhenum	W
4	172	Tithonius Lacus	E
	180	Tithonius Lacus	E
5	180	Tithonius Lacus	E
10	102	Xanthe	E
		Trivium Charontis	W
20	0	Hellas	E
		Argyre	W
22	357	Hellas	E
		Argyre	W

No projections were seen on the limb or terminator.

Changes on Mars. Mention has already been made of the chief changes observed during the opposition, but it may be fruitful to make some attempt at classifying them. It is obvious to anyone who studies the planet that alterations in the surface features may be due to one of two causes:

(a) Apparent changes in certain markings due to clouds, either of dust or of water vapor.

(b) Real changes on the surface of either a seasonal or an irregular nature.

Dealing with (a) first, the following could probably be assigned to this cause:

(1) The veiled appearance of certain southern islands, notably Hellas, Noachis, and Argyre.

(2) The appearance of Ausonia.

(3) The presence of what appeared to be a North Polar Cap.
(4) The invisibility at times of Iuventae Fons, Cerberus, etc.

All these can be explained on the assumption that they were due to clouds. The fact that so many of the southern islands, close to the melting polar cap, were faint seems significant, but there are insufficient data to determine whether there was any connection here. The north polar area has already been discussed; its lack of permanency compared with the South Polar Cap seems in indicate a vaporous nature. In the case of (4) the obscuring matter was probably in the form of dust clouds, evidence of which has been noted many times in the past. In order to trace the development of cloud systems, however, observation must be much more continuous than in the present case.

Under (b) we may classify the following:
(1) The faintness, and at times invisibility, of Pandorae Fretum.
(2) Changes in the Syrtis Major area.
(3) Changes in the neighborhood of Laestrygonum Sinus.
(4) The shape of Solis Lacus.
(5) The development west of Mare Acidalium.
(6) The development on the east of Mare Cimmerium.

Every one of these regions has had a previous history of change, although in the case of the last two there was little cause to expect the developments that did occur, for they were areas which had been comparatively stable for many years.

Pandorae Fretum has long been suspected of undergoing seasonal changes and its faintness in 1939 was to be expected. What the nature of this seasonal change is, it is impossible to say.

In the case of all the other areas mentioned, while their past history does not favor the seasonal theory, it is impossible to escape the feeling that they are all capable of a common explanation. Changes here are all in the nature of a sudden darkening, and subsequent recovery, of a previously light area. As has been shown in the case of Nepenthes-Thoth and Solis Lacus, such a darkening, while not permanent, is always liable to recur. At first sight this may not seem to be the case with the Mare Cimmerium marking, for no profound changes have occurred here in recent years. In 1783, however, Herschel recorded a broadening of Cyclops which was confirmed by Schroeter in 1785. This had increased considerably in 1792 and by 1798 it had formed a huge gulf comparable with Syrtis Major. In 1802 it had diminished considerably and apparently continued to fade during the next few years.[1] Subsequent observation prior to the present opposition, while showing many changes in Cyclops, has revealed no development comparable with that of 1783-1800. The 1939 development, although very similar, appears to have extended in a northerly rather than an easterly direction. Comparable with these Mare Cimmerium changes was the northward extension of Solis Lacus in 1926 and alterations in Nepenthes-Thoth such as occurred

in 1909. Pickering[7] has endeavored to explain changes like these by postulating the flooding of swampy areas, but Mars does not appear to possess enough water for this. Whatever the cause we are faced with the fact that large areas of Mars are liable to undergo these changes more or less frequently.

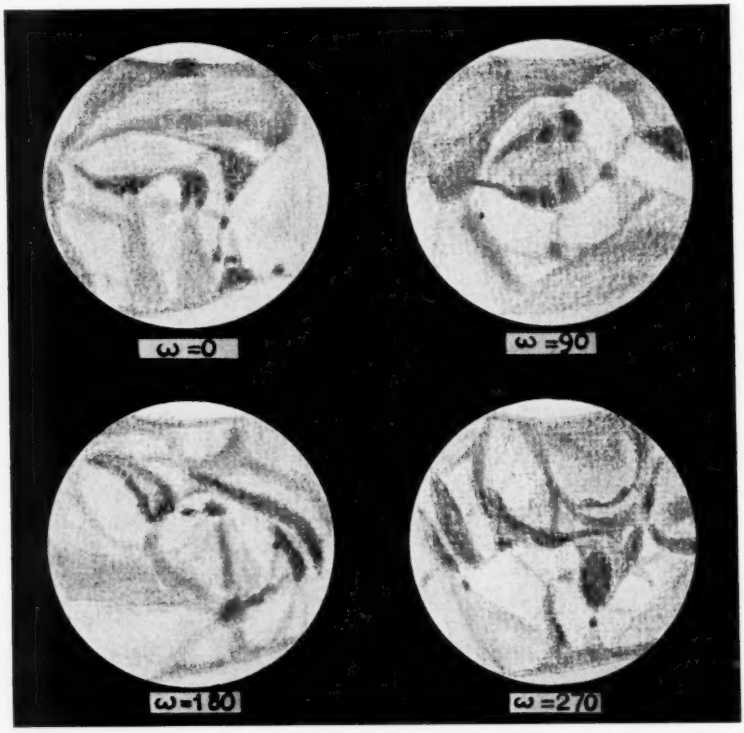


FIGURE 6
COMPOSITE DISC DRAWINGS OF THE SURFACE

The Map of the Surface. This calls for little comment except to point out that no attempt has been made to determine the exact position of the features represented; they have been drawn in in their relative positions. It will be found in most cases, however, that errors in position are very slight. One of the most notable exceptions to this is Mare Acidalium which, by comparison with other maps, appears to be too far to the east, but it has been placed in the position indicated on the drawings. Some attempt has been made to show, by shading, the relative intensities of the different areas, not, however, with any great success. Four composite

disc drawings have also been added showing the aspect of the planet when $\omega = 0°, 90°, 180°, 270°$ (Figure 6).

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WELLINGTON, NEW ZEALAND.

The Revelation in Thunder and Storm

Summarized by MICHAEL S. KISSELL

(Continued from page 549 of preceding issue.)

According to the coördinates of the latter part of the 19th century the right ascension of η Virgo was $13^h\ 48^m$. Therefore, the next question is to determine the date when the sun in its yearly path arrives at the point right under η Virgo. Without difficulties, we find that at noon (St. Petersburg time) on October 10, 1895 (Julian Style), the Sun was located in the very spot, and even until now (1905) it arrives on this date near the very same point. This is invaluable information and renders itself as an excellent starting point for investigation, and we shall proceed in the following manner:

Since from the text of the Apocalypse it follows that this book was written after the death of Christ, we have to compute all the dates in the Julian Calendar on which the sun was observed in the neighborhood of η Virgo. The calculations reveal that during the first centuries of the Christian era, the Sun was near this point around the 30th of September.

It is a pleasant surprise to find supporting evidence as to correctness of our date in the end of chapter 14: Rev. 14—

> . . . thrust in thy sharp sickle and gather the clusters of the vine of the earth for her grapes are fully ripe.

It is evident that it was autumn. Therefore, in checking up on the locations of the four planets previously referred to, we shall be interested in the positions only during September-October of every year. But where was the earth at these moments?

The earth was of course at a certain point in its orbit from which the Sun appeared under η Virgo. Therefore let us agree to call this point of the earth's orbit the *"Apocalyptic point."* Let us place in that point an imaginary observer and proceed with our calculations of positions of the planets as our imaginary observer would see them from the Apoca-

lyptic point. Let us start with Saturn, which in accordance with our record should be found in the constellation of Scorpio. According to the astronomical data on this subject, furnished by Almanacs, we find that the last time this planet entered the constellation of Scorpio was in 1897, and on October 10 of the same year Saturn was located quite near the Scorpion's claw. But, from the beginning of the Christian era until October 10, 1897, there passed 1896 years and 283 days (each year 365¼ days) or altogether 692,797 days. It is quite obvious that, should we repeatedly subtract from this number 10,759.235 days that correspond to one sidereal cycle of Saturn, we shall obtain all the dates on which Saturn was entering the claw of Scorpio. (That is of course for our imaginary observer located at the Apocalyptic point.)

Let us subtract from the total number of days referred to (692,797) in one lump 688,591 days, that is 64 complete cycles of Saturn. Then we will have a remainder of 4,206 days, or in other words, 11 years and 188¼ days from the beginning of the Christian era. That simply means that on the 188th day of the 12th year of our era, Saturn was entering the constellation of Scorpio for the first time after the birth of Christ. However, the Apocalypse could not have been written on this particular date, because at that time Christ was yet a child 11 years of age, while from the book of Revelation it follows that Christ was already ascended. Therefore we shall repeatedly add to this basic date a period of time equal to one complete cycle of Saturn (10,795.235 days, or 29 years and 167 days). By doing so we will obtain all the subsequent dates on which Saturn was entering the claw of Scorpio. They are shown in the table below:

TABLE I

No.	Year	Day	Month	No.	Year	Day	Month
1	12	188	June	8	218	261	Sept.
2	41	354	Dec.	9	248	62	Mar.
3	71	156	June	10	277	230	Aug.
4	100	323	Nov.	11	307	31	Feb.
5	130	125	May	12	336	198	July
6	159	192	Oct.	13	365	364	Dec.
7	189	94	Apr.	14	395	166	June

Now, since the "White Horse" according to our interpretation is the planet Jupiter, which should be found in the constellation of Sagittarius, we, by applying the same method of calculation and the same reasoning as in the case of Saturn, obtain for the planet Jupiter the following table:

TABLE II

(Showing the dates when the planet Jupiter was entering the constellation of Sagittarius.)

No.	Year	Day	Month	No.	Year	Day	Month
1	3	263	Sept.	6	63	10	Jan.
2	15	213	Aug.	7	74	325	Nov.
3	27	162	June	8	86	275	Sept.
4	39	111	Apr.	9	98	224	Aug.
5	51	61	Mar.	10	110	174	June

TABLE II (Continued)

11	122	123	May	23	264	248	Sept.
12	134	73	Mar.	24	276	198	July
13	146	23	Jan.	25	288	147	May
14	157	338	Dec.	26	300	97	Apr.
15	169	287	Oct.	27	312	46	Feb.
16	181	236	Aug.	28	323	361	Dec.
17	193	185	July	29	335	311	Nov.
18	205	135	May	30	347	260	Sept.
19	217	84	Mar.	31	359	210	July
20	229	34	Feb.	32	371	160	June
21	240	349	Dec.	33	383	109	Apr.
22	252	298	Oct.	34	395	59	Mar.

Inasmuch as Jupiter does not remain in the same constellation for longer than 11½ months, we may consider only those of September-October autumns that immediately follow the dates shown in Table I. The comparison of Tables I and II reveals that during the entire period of 395 years there was not a single case when Jupiter would be found in the constellation of Sagittarius simultaneously with Saturn in the constellation of Scorpio. Only in the year 336, there is an indication of possible coincidence; however, a more detailed investigation would disclose that in the year 336, Jupiter was already leaving the constellation of Sagittarius and entering the constellation of Capricorn.

The next, and that is the "Red" horse, is expected to be found under the constellation of Perseus. Since the planet Mars cannot possibly be in conjunction with the constellation of Perseus, because Perseus lies outside of the belt of the Zodiac, the position of Mars for September 30, 395, was computed and it was found that on this day the planet Mars as observed from the Apocalyptic point, would be visible under 34° longitude. Moreover, it disclosed that the true position of Mars was in the constellation of Aries. The natural question arises, why was it that the author of the Apocalypse, instead of a simple statement that Mars was in the constellation of Aries, prefers to designate its position with reference to Perseus? This question has an elegant solution. However, in order to make it clear it is quite important to analyze the 12th verse of chapter 6, which is the key to the solution: Rev. 6:12—

> . . . there was a great earthquake and the Sun became black as sackcloth of hair, and the moon became as blood;

"It immediately occurred to me (writes Mr. Morozov) that a sun-eclipse took place. Fortunately I had on hand a copy of 'Knowledge,' Vol 26, giving an exact formula for determining the position of the moon for any given time. With the aid of this formula, I was able to establish the fact that during the evening of September 30, 395, (and the most probable time is about 5:00 P.M.) there was a ring-eclipse of the sun; however, what is very strange is the fact that this eclipse could have been observed in the central part of South Africa, but by no means could it have been seen from Patmos Island."

Nevertheless, all the apparent contradictions coexist in perfect har-

mony. In the days of the Chaldeans the astronomers were able to predict the solar eclipses by means of the Saros cycle (every eighteen years eleven and one third days). This method, while offering a sufficient precision as to the day on which the eclipse takes place, did not enable astronomers to predict its duration and the area of visibility. Therefore, it appears that John knew well that on September 30 there would be a sun-eclipse, but John could not know the exact time or the area of visibility; but he certainly expected one. Consequently we see beyond doubt that John was a *theologian* and an *astronomer,* or *astrologer.*

Now, just psychologically, assuming that John sincerely and strongly believed in his science, observed all exceptionally bad omens abundantly furnished by the planets, was sure of a sun-eclipse, witnessed an earthquake, he could not help noting the crushing significance of these heavenly signs, which only needed a proper interpretation. Now taking into account that the most probable time of the sun-eclipse was about 5:00 P.M., and bearing in mind that the reference to the "Red" horse was made earlier than the reference to the sun-eclipse, we conclude that the reference to the "Red" horse was made before 5:00 P.M., and that is important, because if we compute the time when Mars was rising and appeared above the horizon, we find that it was very close to 6:00 P.M. In other words, at the time when reference to the "Red" horse was made, Mars was still below the horizon and could not be seen. Therefore, the only way to designate its true location was to designate some other constellation already above the horizon and that was Perseus. Mars was to be found right under it.

Incidentally, if Mars (the God of War) was in the constellation of Aries (the Ram) under a figure "with a great sword in his hand" . . . does it not seem that the proper interpretation would be: The Lamb Resolved To Go To War? I mean from the astrological point of view.

The Fourth, the Black horse, which according to our interpretation is the planet Mercury, should be found in the constellation of Libra. The astronomical calculations showed it very plainly that on this date the planet Mercury was right in the middle of the constellation of Libra.

Wouldn't it be of intense interest, if some qualified professional astronomers would check and confirm the correctness of all these astronomical calculations?

It is quite fortunate that it was done by two competent astronomers, and the document is at hand. The following is an exact translation of a letter sent by Dr. Liapin (Astronomer, Observatory in Pulkovo, Russia) to Mr. N. Morozov.

Dear Sir:

I hasten to advise you of the result of our calculations for the purpose of control of your computations as to the positions of Mercury, Venus, Mars, and the Sun.

All our calculations were made by Dr. Kamensky and myself with the aid of LeVerrier's tables, and quite independently of each other. It should be noted that we did not take into account the planetary perturbations and inequalities of long periods, however we took into account the centennial variations. Thus, for the

equinox of the year 395.0 A.D., we obtained the following set of elements:

	True Longitude	Longitude of Perihelion	Longitude of Ascend. Node	Inclination	Radius Vector
Mercury	298° 1′.4	52° 36′.0	29° 22′.6	6° 58′.8	0.40530
Venus	285 44.7	109 7.5	62 8.0	3 22.4	.72886
Mars	9 52.5	306 36.6	36 57.8	1 52.0	1.45090
Sun	187 29.6	255 32.4	.....	.....	0.99323

On the basis of these data we obtained the following geocentric longitudes and latitudes for September 30, 395, at 0^h of mean Parisian time:

	—For Equinox 395.0 A.D.— Longitude	Latitude
Mercury	211° 20′	— 3° 1′
Venus	226 31	— 1 29
Mars	15 3	— 2 40
Sun	187 30	0 0

In order to plot the positions of these planets on the contemporary star-charts, we reduced the longitudes and the latitudes to the equinox of 1905 and converted them in Right Ascensions and Declinations:

	Right Ascension	Declination
Mercury	299° 3′ = 15^h 16^m.2	—21° 27′
Venus	245 26 = 16 21.7	—23 13
Mars	32 52 = 2 11.5	+15 56
Sun	208	0 0

It can be seen that Mercury was truly found in the constellation of Libra; Venus, in the leg of the Serpent-holder; and Mars under the constellation of Perseus in Aries.

We give all the positions with the precision to 1′, although the precision of observations of that time could be no better than one-tenth of a degree. Incidentally that is the precision of observations made by Hipparchus.

(2)

The computation of positions of Jupiter and Saturn is not as simple as for the above planets. The reason lies in the fact that presently we had to take into account not only the centennial variations, but also the periodic perturbations, and perturbations of long periods. (The great inequality of Jupiter and Saturn, which for a period of time of some 1500 years reached a considerable value strongly affecting the elements; among them the true longitude of orbits and the longitude of the perihelion in particular. For instance, the inequality of long period causes the longitude of Saturn to increase by 52′, and to decrease the longitude of the perihelion by 2°—quantities which by no means could be neglected.)

Therefore in the latter case we took into account: (1) Centennial variations, (2) Inequalities of long periods, and (3) Periodical perturbations (only major terms, neglecting the insignificant terms). As before, the calculations were made by both of us, and entirely independently of each other, for the purpose of mutual control. We obtained sets of the following elements:

	Jupiter	Saturn
True longitude	280° 22′.9	223° 24′.8
Eccentricity angle	9256″	12050″
Major semi-axis	5.20244	9.53808
Longitude of perihelion (395)	349° 7′.5	59° 43′.3
Inclination (395)	1° 23′ 42″.9	2° 32′ 51″.6
Longitude of node (395)	84° 21′.1	99° 39′.3

On the basis of these data we obtained the following geocentric longitudes and latitudes for Jupiter and Saturn for September 30 of the year 395 A.D. at 0^h mean Parisian time:

	Longitude	Latitude
Jupiter	269° 17′	—0° 23′
Saturn	221 58	+1 55

In order to plot these positions on the contemporary star-charts, we related them to the ecliptic of 1905, adding the correction for 1510 years precession of equinoxes (21° 0′ in longitude and —11° 0′ in latitude) and thence converted the obtained longitudes and latitudes into Right Ascensions and Declinations (ecliptic 1905.0).

	Right Ascension	Declination
Jupiter	292° 2′ = 19^h 28^m 1	—22° 29′
Saturn	241 17 = 16 5.1	—19 4

Thus, it is seen that Jupiter was truly in the constellation of Sagittarius, and Saturn in the constellation of Scorpio.

Truly yours,

June 3, 1906.
Pulkovo.

(Signed) N. LIAPIN.

III

Thus it follows that the Apocalypse was written on September 30, 395 A.D., and the sixth chapter in particular, between five and six o'clock in the evening. Could these data throw some light on the true authorship?

In Rev. 1:9 we read: "I John who also am your brother . . . ," and we gather that the name of the author is John. However, it could not be John, the Apostle (the traditional author of the Apocalypse), because he was a contemporary of Christ, and could not possibly survive until 395 A.D. without being definitely recorded in history as an unprecedented case of old age at that time. Therefore we shall go through historical files of the first four centuries of Christianity, with the idea of selecting a man by the name of John, who by inferences or by direct proofs would satisfy a number of diversified requirements:

1. The name is John.
2. He lived in the latter part of the fourth century.
3. In 395 A.D. he was on Patmos Island.
4. In 395 A.D. he was middle aged, perhaps between 30 and 50. It is likely that he was not an "old and feeble man," on the other hand he could not be very young judging from his education.
5. He certainly knew Astronomy: he designated the correct position of Mars while yet below the horizon, and he knew how to predict solar eclipses.
6. He was well accustomed to write in Greek (the original paper is in the Greek language), and shows a literary experience and gift. Therefore it would be logical to assume that he had written other papers noted in history.
7. He was a Christian-theologian.
8. He possessed a rather revolutionary spirit, because he severely criticized the "Earthly Kings."

Since during the fourth century there were not many writers of revolutionary spirit, who lived in the area of Asia Minor—Greece, and were theologians by the name John, we could feel certain that if we find only one who would fill our eight requirements, we really should not try to duplicate him.

To our astonishment, we find right in the end of the fourth century a celebrity, an outstanding character, who not only offers a perfect fit, to all the diversified requirements, but whose fate could not be well explained, unless he was the author of the Apocalypse. This is

JOHN CHRYSOSTOM (345-407 A.D.)

For further reference I copy his short biography from Adair's New Encyclopedia 1924, New York.

> CHRYSOSTOM (345-407) generally called Saint John Chrysostom. One of the greatest Greek Fathers, baptized in 369. Lived for some time the life of a recluse; was deacon and priest at Antioch, Bishop of Constantinople 398, but exiled 404; wrote De Sacerdotio, a treatise on the priesthood, and many Homilies on books of the Bible; belonged to the Antioch school; called "Chrysostom" or "Golden Mouthed" because of oratorical gift.

Furthermore, there are three very interesting details in John's biography. One I take from "Everybody's Complete Encyclopedia": "His attacks on wickedness in high places led to his banishment in 403." The other two I take from "The Standard American Encyclopedia" (v. 4)—

> 1. . . . in 386 he was consecrated priest, and commissioned to preach to the people (until 397).
> 2. . . . The Empress Eudoxia caused him to be deposed. The Emperor banished him from Constantinople, but the people threatened a revolt, and alarmed by an earthquake the following night, Arcadius recalled his orders, and Eudoxia invited Chrysostom to return.

The last comment is very significant, and it is readily understood after the essence and the purpose of John's prediction is briefly discussed.

Let us consider the six following verses from the Apocalypse:

11:2 . . . and the holy city shall they tread under foot forty and two months.
11:3 .. . and they shall prophesy a thousand two hundred and threescore days.
12:6 . . . that they should feed her there a thousand two hundred and threescore days.
11:9 . . . and nations shall see their dead bodies three days and half.
13:5 . . . and power was given unto him to continue forty and two months.
12:14 . . . where she is nourished for a time, and times, and half a time.

We see at a glance that the verses 11:3 and 12:6 both speak about the very same number of days, namely, 1260.

Furthermore, the verses 11:3 and 13:5 both speak about a period of 42 months, and if we assume a month equal to 30 days, we arrive at the same figure, *i.e.*, $42 \times 30 = 1260$ days.

The verse 12:14 makes hardly any sense in its present form, because John, while speaking about the duration of the period of nourishment goes even into fractions (and half a time) for the sake of precision, while on the other hand he adds very indefinitely "and times . . ." without specifying "how many."

This apparent inconsistency becomes quite clear, if we consider the fact that in the grammar of the Greek language (the original text was written in Greek) there is instead of only "Singular" and "Plural" numbers, as we find in English, one more form called "Dual." That is, we may speak of One, Two, or Many.

The Dual could not possibly be expressed in English otherwise than as "Plural." Therefore we have to assume an error on the part of the Scribe, and read: ". . . where she is nourished for a time, and two times, and half a time," or altogether, *three and a half times.* Consequently the period of nourishment is expressed twice: once as 1260 days and another time as 3½ times. How long is "One time"? 1260 ÷ 3½ = 360 days, or beyond doubt, one year. Therefore, the expression "three and a half times" we shall interpret as 3½ years. Confronting this result with verse 12:9, we observe that in the latter John speaks about *"three days and a half."*

Inasmuch as the original Greek word ημερα means also "a period" or "a cycle of time," and is well fit for metaphoric use, we cannot help but feel that John when speaking about three and half solar periods meant three and half years. Now, three and half years make the very same 42 months or 1260 days.

The question is, what was the reason that prompted John to make such numerous references to this period designating it six times in four different terms?

The most natural assumption is that John, while placing a grave importance in this period, feared that it could be either changed or passed unnoticed. Thus, on the day of September 30, 395, John wrote in Rev. 11:3—

> . . . And I will give power unto my two witnesses, and they shall phophesy for . . . 1260 days.

Therefore, adding 1260 days to September 30, 395, we arrive at the presumably most important day, March 13, 399.

What significance could this date have? It is ascertained that it was also a Sunday. Therefore the best we can do is to re-write the verse 11:3 as—

> . . . and they shall prophesy until March the 13th, 399.

And what thence? Let us attack the problem from another angle. Inasmuch as March 13th of 399 is a future date, and of outstanding importance, there should be more than one reference made to the essence of the prediction that was revealed in the vision. To our deep satisfaction, besides a number of places scattered throughout the Apocalypse that give inferences as to The Day of Great Judgment, we find practically the whole of chapter 20 devoted to the description of This Day.

> Verse 4: And I saw thrones, and they sat upon them and Judgment was given unto them . . .
> Verse 12: And another book was opened, which is the book of life; and the dead were judged out of those things which were written in the books, according to their works.
> Verse 13: And death and hell delivered up the dead which were in them: and they were judged every man according to their works.

It leads us to the apparent conclusion that John predicted the Day of the Great Judgment (the end of the world) for March 13, 399. The

fact that John, guided by his theological and astrological principles, had chosen the particular day of Sunday, March 13 of the year 399, will be much clearer presently.

Let us recall that the present system of chronology, *i.e.*, indicating the number of the year as "after the year of the birth of Christ," came into official use only during the 10th century A.D., while during the first four centuries of the Christian era all the dates were reckoned "from the foundation of Rome." At that time, the exact day, month, and the year of the birth of Christ, were not yet officially established. It was only during the 6th century A.D., on the basis of the work of a monk Dionysius Exiguus, that the date of Christ's birth was set as Saturday, December 25th, in the year of 753 from the foundation of Rome.

But, before this official announcement was made, there were habitual arguments among various factions of the early Christians. As a matter of fact some learned theologians of the present time believe that the true date of Christ's birth is two years earlier than the officially accepted one. Although it may seem strange that such a question as the exact date of Christ's birth led to bitter arguments among the early Christians and the disputed periods were expressed in years, it appears that they had a good reason to disprove each other, and it is just by sheer luck that at the time this paper was written, a splendid supporting evidence was published in *The Washington Daily News,* Friday, February 24, 1939 (page 10):

ASTRONOMER SAYS THIS YEAR IS ACTUALLY 1943

(By United Press)

Philadelphia.—This year should be 1943 A.D. or perhaps 1944 or 1945 rather than 1939, according to James Stokley, associate director of the Franklin Institute in charge of astronomy.

Josephus, the great historian, wrote that King Herod died soon after an eclipse of the moon, Stokley said, and the only such eclipse of that time in the Holy Land occurred on March 13, 4 B.C.

Since Christ was born before Herod's death, his birth must have occurred at least four years before the time set by the Christian calendar, the astronomer explained.

It all shows that if John belonged to the faction that believed (as it will be shown later) that the actual date of Christ's birth is two years earlier than the official one, he was right on two counts: 1. That the date of Christ's birth was an earlier date. 2. He was only half as far from the truth as the official date. It is remarkable that the latter theory brings the key for the solution.

If John considered the true date of Christ's birth two years earlier, then he reckoned that the day of September 30, 395, was really (from his point of view) September 30, 397 (and not of 395), consequently the Day of the Great Judgment was predicted by him for March 13, 401, (and not 399). And this is extremely important:

The Jews counted their New Year Day on the day of the Spring Equinox, *i.e.*, on the 20th of March (of that year). In other words the 13th

of March was the last Sunday of the fourth century; that is, the expiration of full four hundred years after Christ's birth.

Now, the period of four hundred years had some mystic significance in the Jewish time reckoning as they counted. For instance, 400 years from the birth of Isaac to Babylonian captivity; 400 years from the foundation of the temple to the fall of Ninevah; 400 years from the death of Nehemiah to the birth of Christ. I understand that some of these periods are proven to be incorrect (according to the tradition, the duration of the Babylonian captivity was also considered 400 years), but I have no idea of attempting to prove the correctness of such periods, though I like to emphasize that there was a traditional belief in the significance of the 400-year periods.

Consequently, since March 20 would be already the First Sunday of the first year of the fifth century, we may speculate that the week between March 13 and March 20 was to be the Seven days of the Judgment (represented as seven seals and seven vials) following which the Kingdom of Christ was expected to be established.

Now, if we take all the above into exact account, some rather mysterious parts of John's biography would be readily understood. Let us recall that in the year 386, John was commissioned to preach to the people. John remained in this position of a "travelling preacher" for about 11 years, when all of a sudden the Emperor Arcadius in 397 placed him as Archbishop (Patriarch) of Constantinople. Such a career in one jump could be hardly believed. But far more astonishing is the "technique" of bringing John to Constantinople, and his inauguration.

At the time of the Emperor's decision to have John appointed as the archbishop of Constantinople, John was in Antioch, so the Emperor sent a special ambassador to Antioch escorted by a "Guard of Honor," to extend his invitation to John.

It is most surprising that John, instead of receiving the ambassador, locked himself up in the church, and in a short while there was a wild crowd of the population gathered around the church, in order to protect John. The reason for John's panic is not well established. But what is established is the fact that a short time before that the Imperial statues, which were placed in the parks of Antioch, were broken and thrown down. . . . Some mean tongues comment that it was done under the personal supervision of John. . . At any rate John remained locked up, and the special ambassador, after some fruitless attempts, had to give up the job and returned to Constantinople "empty handed."

The question is: What would be the most usual reaction of (any) Emperor in response to such insult or disobedience? To our astonishment we learn that after the first failure, the Emperor effected his design by acting through the mayor of the city of Antioch, who, under pretext of discussing some matters of religious doubts, tricked John into the suburbs of the town, and when John, unaware of the trap, appeared, another imperial messenger, a man by the name of Asterius, with the aid

of his men, actually kidnapped John, placed him into a vehicle, and under a heavy guard delivered him to Constantinople.

Perhaps John could think that it was high time to prepare himself for the worst. . . . however, upon his arrival, and that was on February 26, 398 (or 400 as John reckoned), John was met by a special reception committee, sent by the Emperor, and was received with great honors . . . (for details, see Aimé Puech: St. Jean Chrysostome).

Here is one very important detail. John called to the attention of the Emperor that he could not become the Archbishop of Constantinople unless his appoinment is sanctioned by the "Council of Bishops." The Emperor willingly agreed, the "council" was called, and John became the Patriarch of Constantinople without difficulties. This little incident is a proof that John became the Archbishop of Constantinople in the most unusual and unprecedented way. The question is: What made the Emperor so meek and so agreeable? Perhaps we find the answer in Rev. 17:10, 11—

> And there are seven kings, five are fallen and one is, and the other is not yet come; and when he cometh he must continue a short space. And the beast that was and is not, even he is the eighth, and is of the seven, and goeth into perdition.

Now, the Apocalypse was written in the time of Emperor Theodosius. Emperor Arcadius followed him, and was exactly the seventh who according to the prediction was *the very last one* . . . and I think this is the answer. It was panic before the "end of the World." As a matter of fact, even in much later dates, as for instance in 1680, a bright comet appeared in Europe and created so much excitement in Germany (many people made their wills, etc.) that a special medal was struck and widely distributed to restore quiet. On one side was the picture of the comet and on the other the words: "Only trust, God will make things turn to good" (from "Astronomy," by Arthur Harding, 1935).

It was the panic before the Day of Judgment, that made the Emperor (and perhaps the "Council") comply with John's words, and to stand his offenses. However, the fatal day had passed . . . and nothing happened. What then? Well, perhaps what always happens in such cases. John's biography informs us: ". . . he incurred many enemies, and Theophilus, Patriarch of Alexandria, aided by the Empress Eudoxia caused him to be deposed." Thus, John was actually put on a ship, and the ship left the harbor.

But, curiously enough, an earthquake happened that very night. Now, just psychologically, could this be anything but "God's Wrath"? Did it not begin to look like: Rev. 16:18—

> . . . "and there was a great earthquake" . . .

That according to the prediction preceded the beginning of the Judgment. It appears that the effect of this earthquake (which damaged only a moderate number of buildings), despite its mildness, was terrific

The History discloses: "the people threatened a revolt, the Emperor recalled his orders, and Empress Eudoxia invited Chrysostom to return: "I beg Your Emminence not to believe in my participation in what happened to You . . . (she wrote) and may God witness the Truth of my words, and the sincerity of my tears."

Elsewhere above I mentioned that the biography of John Chrysostom would be better understood if we assume that he was the author of the Apocalypse, but at the present moment I feel that his biography could not possibly be understood unless he is the true authentic author of the book.

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Planetary Phenomena in 1941

By R. S. ZUG

Note: Greenwich Civil Time (Universal Time) is employed unless otherwise stated. This is Standard Time in England, and is reckoned from Greenwich midnight through 24 consecutive hours. To obtain Eastern Standard Time, subtract 5 hours from Greenwich Civil Time. To obtain Central Standard Time, subtract 6 hours, etc. The numerical data utilized in the preparation of this article are taken chiefly from the *American Ephemeris and Nautical Almanac*. The positions of Pluto utilized in the construction of Figure 3 were obtained by extrapolation from the 1939 and 1940 numbers of the *Berliner Astronomisches Jahrbuch*.

Eclipses

There will be two solar and two lunar eclipses in 1941.

I. *A partial eclipse of the moon will occur March 13, 1941.* The beginning of this eclipse will be visible generally in North America, except the extreme northeastern part, the western part of South America, the Pacific Ocean, Australia, Eastern Asia, and the eastern part of the Indian Ocean. The ending will be visible in the western portion of North America, the Pacific Ocean, Australia, Eastern Asia, and the eastern part of the Indian Ocean.

Circumstances of the Partial Lunar Eclipse of March 13, 1941:

	G.C.T. d h m
Moon enters penumbra	March 13 9 37.6
Moon enters umbra	13 10 55.1
Middle of eclipse	13 11 55.4
Moon leaves umbra	13 12 55.8
Moon leaves penumbra	13 14 13.1

Contacts of umbra with moon's limb	Angles of position from the north point
First	50° to E.
Last	17° to W.

Magnitude of eclipse = 0.328 (Moon's diameter = 1.0)

II. *An annular eclipse of the sun will occur March 27, 1941.* The path of the annular eclipse begins in the Pacific Ocean southeast of New Zealand in longitude 177° 51′ E., latitude 47° 54′ S. The eclipse track extends from this point in a north-

easterly direction over the Pacific Ocean, then easterly across half the continent of South America ending at longitude 56° 43′ W., latitude 12° 43′ S., as illustrated in Figure 1. It is interesting to note that the partial phase of the eclipse will be visi-

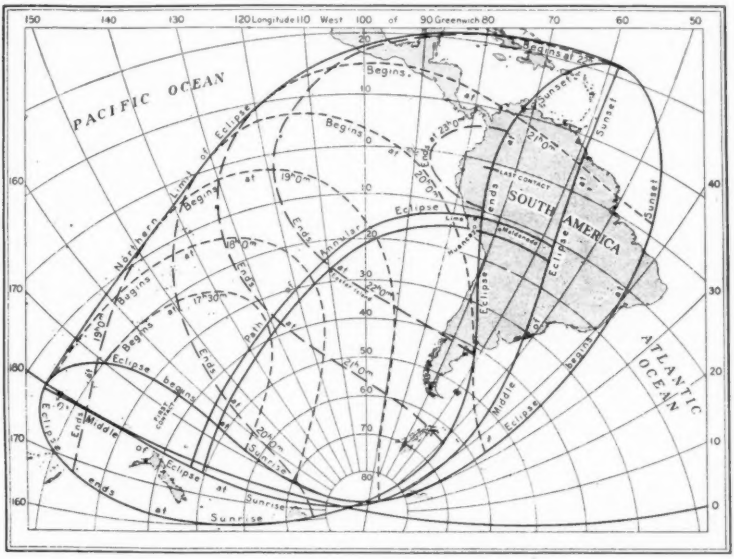

FIGURE 1

ANNULAR ECLIPSE OF MARCH 27, 1941 (From the *American Ephemeris*)
Note: The hours of beginning and ending are expressed in Universal Time (G.C.T.)

ble in Central America as far north as the Gulf of Mexico. At Panama, Panama, the magnitude of the eclipse (in terms of the fraction of the sun's diameter obscured at maximum eclipse) will be 36%, at $21^h\ 58^m$ G.C.T. At San Juan, Porto Rico, the eclipse will attain magnitude 9% at $22^h\ 5^m$ G.C.T. The Greenwich Civil Time of the beginning and ending of the eclipse for any point within the eclipse area can be interpolated with fair accuracy from the data of Figure 1.

Circumstances of the Annular Eclipse of March 27, 1941:

		G.C.T. d h m	Longitude ° ′	Latitude ° ′
Eclipse begins	March	27 17 12.3	+164 46	—36 23
Central eclipse begins		27 18 25.8	—177 51	—47 54
Central eclipse at local app. noon		27 19 48.9	+115 53	—29 19
Central eclipse ends		27 21 49.8	+ 56 43	—12 43
Eclipse ends		27 23 3.3	+ 74 32	— 1 9

III. *A partial eclipse of the moon will occur September 5, 1941.* The beginning of the eclipse will be visible in the northwestern extremity of North America, the western half of the Pacific Ocean, Australia, the Indian Ocean, Asia, eastern Europe, and Africa except the northwestern part. The ending will be visible in the

western part of the Pacific Ocean, Australia, the Indian Ocean, Asia, Europe except the southwestern part, and Africa except the extreme northwestern part.

Circumstances of the Partial Lunar Eclipse of September 5, 1941:

	G.C.T. d h m
Moon enters penumbra	September 5 15 25.3
Moon enters umbra	5 17 18.9
Middle of the eclipse	5 17 46.9
Moon leaves umbra	5 18 14.6
Moon leaves penumbra	5 20 8.3

Contacts of umbra with moon's limb	Angles of position from the north point
First	149° to E.
Last	177° to E.

Magnitude of eclipse = 0.056 (Moon's diameter = 1.0)

IV. *A total eclipse of the sun will occur September 21, 1941.* The area over which the eclipse is visible is illustrated by Figure 2. It will be seen from exam-

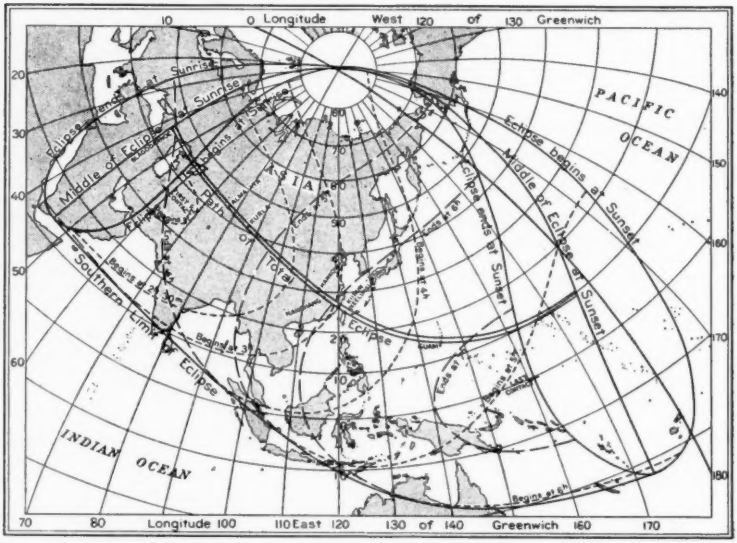

FIGURE 2

TOTAL ECLIPSE OF SEPTEMBER 21, 1941 (From the *American Ephemeris*)
Note: The hours of beginning and ending are expressed in Universal Time (G.C.T.)

ination of Figure 2 that the eclipse will be visible in its partial phases over the eastern part of Europe, practically all of Asia, and Asia Minor, and the western part of the Pacific Ocean as far south as Australia and as far north as Alaska. The path of totality begins near Blagodarnoe in South Russia, and runs in a southeast by easterly direction across Asia, then easterly over the Pacific Ocean

as far as longitude 176° 39′ E., latitude 9° 58′ N. Here the axis of the shadow cone of the moon loses contact with the earth at sunset.

At Manila, Philippine Islands, the eclipse will reach a magnitude of 72% at $4^h\ 59^m$ G.C.T. At Nome, Alaska, the eclipse will reach a magnitude of 3% at $4^h\ 48^m$ G.C.T.

Circumstances of the Total Solar Eclipse of September 21, 1941:

	G.C.T. d h m	Longitude ° ′	Latitude ° ′
Eclipse begins September	21 1 58.4	— 58 4	+35 33
Central eclipse begins	21 3 0.2	— 42 22	+45 44
Central eclipse at local app. noon	21 4 17.8	—113 52	+30 18
Central eclipse ends	21 6 7.2	—176 39	+ 9 58
Eclipse ends	21 7 8.8	—161 5	— 0 14

Planets

Visibility of the Planets. The visibility of the planets for any date may be found from examination of Figure 3, which shows for any date the difference in right ascension between each planet and the sun. If the graph of a planet lies to the right of the zero line on a given date, the planet is a morning star; if to the left, then the planet is an evening star. A planet should be one or two hours east or west of the sun to be easily observable in the evening or morning sky, as the case may be. Where the graph of a planet intersects the 12-hour line, the planet is in opposition, and the corresponding ordinate gives the date of opposition. Where the graph pertaining to a superior planet crosses the zero line, the planet is in conjunction on the corresponding date. An inferior planet may be in superior or inferior conjunction, depending on whether it had previously been a morning or evening star, respectively. When two graphs intersect, the corresponding planets are in conjunction with one another on that date. The declination of each planet is indicated at intervals along the respective curves, usually at points corresponding to dates upon which the declination is represented by an integral number of degrees. If the declination is given to the tenth of a degree, it usually signifies that a maximum or minimum is reached on the day in question.

An unusual series of conjunctions between planets will occur during the first two weeks of May. All of the planets involved will at that time be situated close to the sun. They must, therefore, be observed in the daytime, and, except for Venus, are observable only with telescopic aid if at all. The 6th magnitude planet Uranus, one of the group, is, of course, unobservable in the daytime even with large telescopes. The list of conjunctions follows:

Planetary Conjunctions in May, 1941

G.C.T. h	Conjunction between	Angular separation	Planet to the North	Elongation from Sun
May 4 18	Venus and Saturn	1° 33′	Venus	5° E
7 7	Jupiter and Uranus	0 32	Uranus	10 E
7 17	Mercury and Saturn	2 19	Mercury	2 E
11 4	Venus and Uranus	0 5	Uranus	6 E
11 5	Mercury and Uranus	1 3	Mercury	6 E
11 6	Mercury and Venus	1 8	Mercury	6 E
11 13	Mercury and Jupiter	1 38	Mercury	6 E
11 20	Venus and Jupiter	0 28	Venus	6 E

Noteworthy is the series of five conjunctions on May 11, involving the planets, Mercury, Venus, Jupiter, and Uranus. The exact instants of the respective con-

VISIBILITY OF THE PLANETS FOR 1941

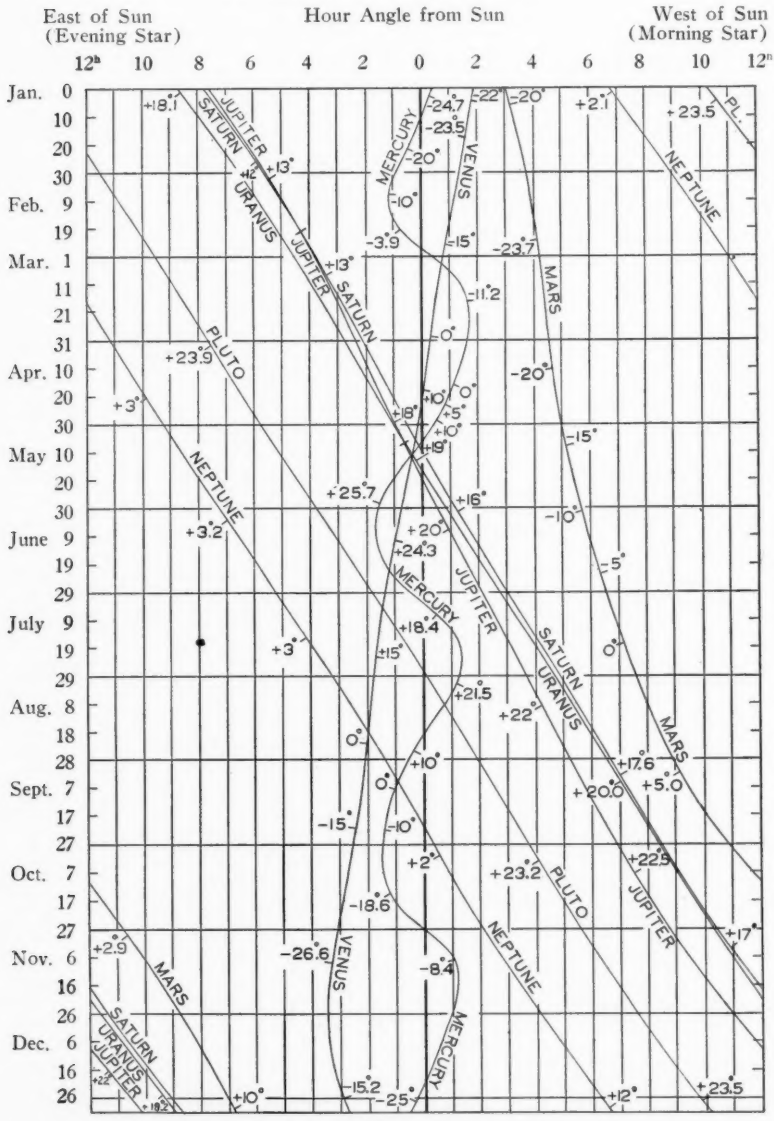

FIGURE 3

junctions are perhaps of no practical significance to observers, who may profitably attempt observation of the interesting cluster of planets at any time during the day. For the benefit of those who may desire to construct a chart illustrating the relative positions of the four planets, the right ascension, declination, and stellar magnitude of each planet are tabulated below, as of May 11, 12^h G.C.T. The apparent motion of Mercury for the 24-hour period from May 11.0 to May 12.0 is $8^m.5$ easterly in right ascension, and 40′ northerly in declination. Corresponding figures for the motion of Venus are, respectively, $5^m.0$ easterly and 20′ northerly, while Jupiter moves eastward 1^m and northward 3′ during the same period.

Positions and Magnitudes of Planets on May 11, 12^h G.C.T.:

Planet	α h m	δ ° ′	Magn.
Mercury	3 36.8	+20 15	—1.6
Venus	3 35.9	+19 2	—3.4
Jupiter	3 37.3	+18 40	—1.6
Saturn	3 5.8	+15 20	+0.4
Uranus	3 34.2	+19 0	+6.0
Sun	3 11.8	+17 51	...

In observing planets near the sun, care must be taken not to direct the telescope at the sun while looking through the eyepiece. To avoid this danger, and also to avoid the disadvantage of scattered and reflected sunlight within the telescope tube, it is advisable either to place the telescope in the shade of a building in such a manner that the planets remain in view, or to arrange an appropriate shade screen of some sort several feet before the lens.

Mercury. Mercury will be a conspicuous evening star, for observers in the northern hemisphere, around February 11 and June 6, dates of greatest elongation. The planet will be less conspicuous at the time of the greatest eastern elongation, October 3, due to its southerly declination. The planet will be visible in the morning sky around March 25, July 24, and November 12, just before sunrise.

At greatest eastern elongation on February 11, Mercury will be situated about 2° northwest of the 3.8 magnitude star λ Aquarii, while at greatest eastern elongation on June 6, the planet will be situated 2° SE of the 3.2 magnitude star ε Geminorum. The greatest elongations of Mercury from the sun during 1941 are listed below, with the stellar magnitude of the planet at each elongation.

Greatest Elongations of Mercury from the Sun in 1941:

Eastern Elongation (Evening Star)			Western Elongation (Morning Star)		
Date	G.E. East	Magn.	Date	G.E. West	Magn.
Feb. 11^d 0^h	18° 10′	—0.4	Mar. 25^d 15^h	27° 48′	+0.5
June 6 4	23 47	+0.7	July 24 4	20 0	+0.5
Oct. 3 5	25 42	+0.2	Nov. 12 3	19 11	—0.3

A number of planetary conjunctions of interest involving Mercury are discussed under *Visibility of the Planets.*

Venus. The planet Venus will be found in the morning sky during the first few months of 1941. Superior conjunction occurs on April 19, 7^h, at which time Venus will be situated 1° 1′ to the south of the center of the sun's disk. After superior conjunction on April 19 the planet will be an evening star, and should be quite conspicuous after sunset by June 1. As an evening star the planet attains a maximum elongation of 47° 16′ on November 23, 5^h, while greatest brilliancy will be attained on December 29. Data of interest to observers are tabulated below.

VENUS IN 1941

Date 1941	Distance from earth in miles	Angular Diameter	Fraction of disk seen illuminated	Stellar Magnitude
	(Morning Star)			
January 1	135,489,000	11".5	0.90	—3.4
January 31	146,656,000	10.6	0.95	—3.4
March 1	154,536,000	10.1	0.98	—3.4
April 1	159,530,000	9.8	0.998	—3.4
April 19, 7^h	160,577,000	9.7	1.000	—3.5
April 19, 7^h	Superior Conjunction			
	(Evening Star)			
May 1	160,419,000	9.9	0.998	—3.5
June 1	156,570,000	10.0	0.98	—3.4
July 1	147,960,000	10.6	0.94	—3.3
August 1	134,479,000	11.6	0.88	—3.3
September 1	117,406,000	13.3	0.80	—3.4
October 1	98,565,000	15.9	0.71	—3.6
November 1	78,279,000	20.2	0.60	—3.8
December 1	56,633,000	27.6	0.46	—4.2
December 31	36,841,000	42.4	0.25	—4.4

A number of conjunctions between Venus and other planets will occur in May, and are described under *Visibility of the Planets*. A conjunction of Venus and Neptune will take place August 18, 0^h, at which time Venus will pass 18′ to the south of Neptune.

An occultation of Venus will occur August 25, visible in Asia, East Africa, India, and the Malay Archipelago, between extreme latitude limits 66° N. and 7° S. The G.C.T. of geocentric conjunction in right ascension is 7^h 45^{m}3. The occultation will occur in the daytime in the regions named.

Earth. The earth will be in perihelion January 3, 18^h, and in aphelion July 3, 0^h. Spring begins March 21, 0^h 21^m, when the sun reaches the vernal equinox. Summer begins June 21, 19^h 34^m, when the sun reaches the summer solstice. Fall begins when the sun passes the autumnal equinox September 23, 10^h 33^m, and winter, December 22, 5^h 45^m, when the sun reaches the winter solstice.

Mars. The planet Mars will be a morning star during the first part of 1941. Western quadrature will occur on June 2. The planet will reach the perihelion point of its orbit on August 4. It will be closest to the earth October 3, 7^h, when its distance will be 38,130,900 miles. Opposition will occur October 10, 13^h. The stellar magnitude near opposition will be —2.4.

The apparent path of Mars in 1941 extends from a point near the western boundary of Scorpio easterly through the constellation Scorpio, Sagittarius, Capricornus, Aquarius, and Pisces, a narrow loop being described in the latter constellation toward the end of the year. The motion of the planet is direct until September 6. From September 6 to November 12, the planet will be in retrograde motion, direct motion then ensuing for the remainder of the year. On June 30 the planet will be situated on the equinoctial colure and 3°.5 south of the vernal equinox. An occultation of Mars will occur on November 1, the G.C.T. of the conjunction in right ascension being 14^h 35^{m}4. The occultation will be visible in Asia, India, Australia, and the Malay Archipelago, between the extreme latitude limits 40° N. and 28° S.

Data concerning Mars in 1941 are listed in the following table, the contents of which are largely self explanatory. The use of the data in columns (4), (5), (6), and (7) is discussed in subsequent paragraphs.

MARS IN 1941

(1) Date 1941 0^h G.C.T.	(2) Distance from Earth (miles)	(3) Ang. Diam.	(4) —Center of Disk— Lat.	(5) Long.	(6) Increase in Long. per day	(7) *P.A. of S. P.	(8) Magn.
Jan. 1	201,096,000	4".3	....	.....	.....	....	...
Jan. 31	179,579,000	4.8	....	.....	.....	....	...
Mar. 1	157,484,000	5.5	....	.....	.....	....	...
Apr. 1	133,900,000	6.5	13° S.	252°.8	350°.24	10° W.	+0.9
May 1	112,239,000	7.7	19 S.	319.5	350.20	3 E.	+0.6
June 1	91,722,000	9.5	22 S.	15.6	350.20	15 E.	+0.1
July 1	73,900,000	11.8	22 S.	82.4	350.28	25 E.	—0.4
Aug. 1	57,631,000	15.1	20 S.	143.6	350.47	31 E.	—1.0
Sept. 1	44,431,000	19.6	18 S.	213.0	350.84	34 E.	—1.7
Oct. 1	38,169,000	22.8	19 S.	303.6	351.20	33 E.	—2.4
Nov. 1	44,144,000	19.7	23 S.	29.4	351.00	30 E.	—1.9
Dec. 1	61,147,000	14.2	24 S.	113.3	350.60	31 E.	—0.9
Dec. 31	84,443,000	10.3	23 S.	187.9	350.38	35 E.	0.0

*Position Angle of South Pole with reference to the south point of the disk.

The 1941 opposition of Mars will be an important one for planetary observers. For observers in the northern hemisphere the opposition will be much more favorable than that of 1939, when the declination of Mars was —26°. During the period of closest approach in 1941 the planet will have a declination of about +4°, and, as seen from the northern hemisphere, will therefore transit the meridian 30° nearer the zenith than in 1939, with corresponding greatly improved seeing conditions. In 1939 the maximum angular diameter attained by the planet was 24".1, while in 1941 the maximum will be 22".8, on October 3. The difference will be of no consequence to most observers.

During the opposition of 1941 the southern hemisphere of Mars will be seen more directly than the northern, the south pole being visible from the earth. At this opposition the southern hemisphere of Mars will be experiencing mid-summer while winter will be in full swing in the northern hemisphere. For Mars, the sun will reach the Martian "summer solstice" on September 10. On October 3, the date of closest approach to the earth, the latitude of the center of the planetary disk will be about 19° S. (measured from the planet's equator). On the same day, the south pole of Mars will be seen near the southern limb of the planet, and on a radius of the disk intersecting the limb 33° to the east of the south point (point on the disk farthest from the north celestial pole). The value of this angle for the first of each month of the 1941 observing season is listed in the above table in column (7), "Position angle of the South Pole." Similarly, column (4) lists the Martian latitude (measured with respect to the equator of Mars) of the center of the disk for the various dates. Column (5) lists the planetary longitude of the center of the disk for 0^h G.C.T. Knowing the planetary longitude at a given time, the surface markings visible on the planet may be identified by reference to Figure 4, which is reproduced from the article by William H. Pickering in POPULAR ASTRONOMY, **24**, 236, 1916.

To find the longitude of the center of the disk for a time not listed in the table, one may make use of the figures in column (6) which give for each tabulated date the increase in the longitude of the center of the disk per 24-hour period. As an example, suppose we wish to know the longitude of the center of the disk for August 29, 0^h, Central Standard Time. This is equivalent to August 29, 6^h G.C.T., or August 29.25 G.C.T. The time interval since the preceding tabulated date (Aug-

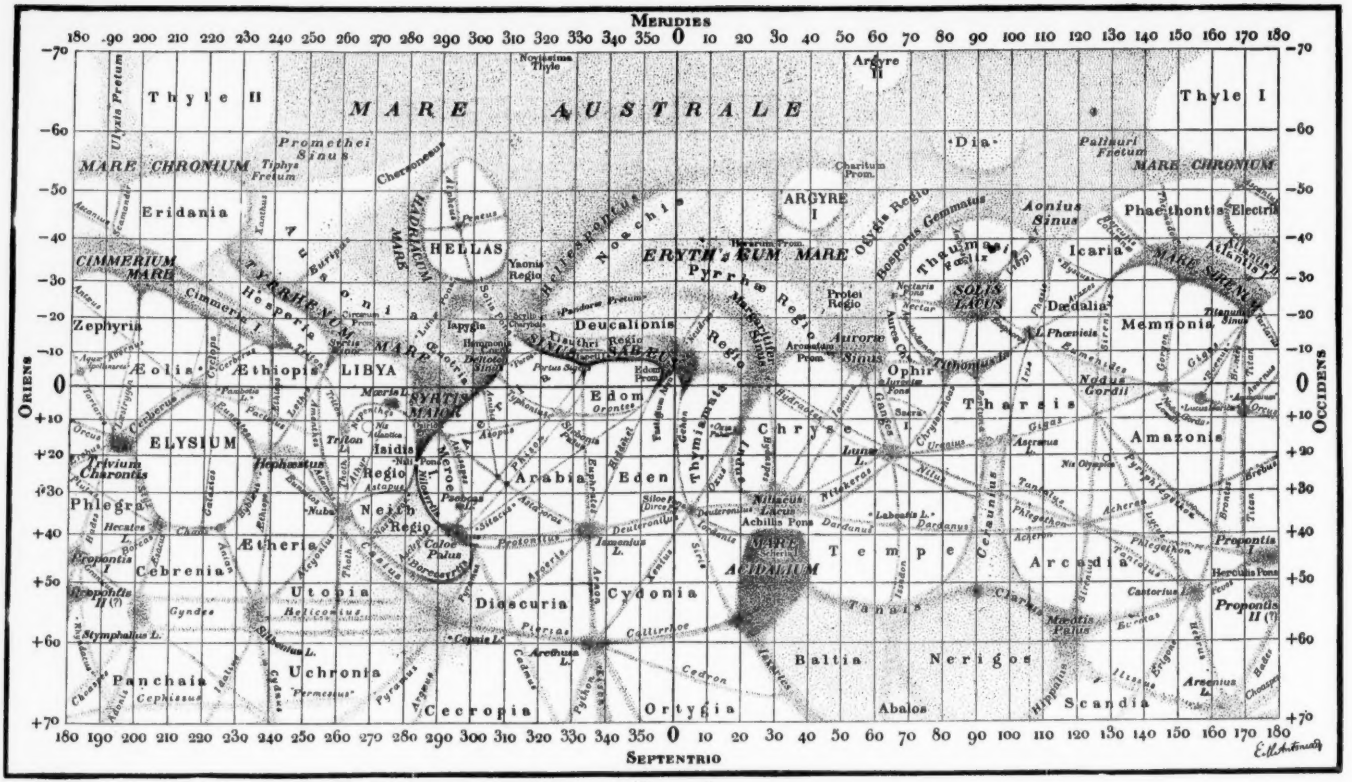

FIGURE 4
GENERAL CHART OF THE PLANET MARS BY FLAMMARION AND ANTONIADI
(From "La Planète Mars" Tome II)

ust 1) is therefore 28.25 days. Multiply 28.25 by the daily increase, in this case by 350°.47, and add the product to 143°.6, the value of the longitude for August 1.0. The number thus obtained is then divided by 360, and the remainder, which is 324°.4, is the computed value of the longitude of the center of the disk for the time August 29, 0^h C.S.T. Expressed arithmetically,

$$\frac{(350.47 \times 28.25) + 143.6}{360} = 28 + \frac{324.4}{360},$$

the remainder, 324.4, representing the value of the longitude for the date in question. The value obtained by the process will always be within 5° of the true value. If one desires greater precision, he may interpolate from column (6) for the daily increase for the date midway between August 1 and August 29, in this case August 15. The value thus obtained for August 15 is 350°.65. With this value, the longitude is computed to be 329°.5. The true value, taken from the *American Ephemeris,* which lists the data for 2 day intervals, is 328°. Having computed the longitude of the central meridian for some one hour of the night, the corresponding central longitudes at other hours may be found by allowing for an increase of 14°.6 per hour.

Jupiter. Jupiter will be an evening star during the first part of 1941. The planet will reach eastern quadrature on January 27. Conjunction will occur May 19, 20^h, with Jupiter situated 41′ south of the center of the sun's disk. The planet then becomes a morning star, and will reach western quadrature September 13. Opposition will occur December 8, 20^h. The stellar magnitude of the planet will vary from —2.2 on January 1 to —1.5 at the time of conjunction, then to —2.4 at the time of opposition.

Jupiter will be moving through the constellations Aries and Taurus in 1941. The apparent motion is direct until October 10, after which it is retrograde for the remainder of the year. A conjunction of Jupiter and Saturn will occur February 20, 19^h, with Jupiter 1° 21′ to the north of Saturn. This is the third of a series of three conjunctions between the two planets, of which the first two occurred in 1940, on August 15 and October 11. Consecutive conjunctions with Uranus, Mercury, and Venus, will occur in May, as described under *Visibility of the Planets.*

Saturn. Saturn will be an evening object during the first part of 1941, reaching eastern quadrature on January 28 and conjunction on May 9. After conjunction the planet will be situated in the morning sky, and will reach western quadrature on August 21. Opposition will occur November 17, 19^h. The stellar magnitude of the planet, which will be +0.4 on January 1, will reach —0.1 at opposition in November.

The ring system of Saturn is approaching its maximum apparent width. On January 1, 1941, the angular dimensions of the major and minor axes of the outer ellipse of the outer ring will be, respectively, 42″.9 and 13″.7. At opposition on November 17, the corresponding values will be 46″.1 and 18″.2. The southern side of the ring system is in view.

Saturn will be in conjunction with Jupiter on February 20, as described under *Jupiter.* Conjunctions with Venus and Mercury occur in May as described under *Visibility of the Planets.* Three occultations of Saturn will occur during 1941, the respective times of geocentric conjunction of the moon and the planet being (1) January 7, $12^h\,16^m.5$, (2) February 3, $21^h\,27^m.9$, and (3) March 3, $8^h\,43^m.6$. Conjunction (1) will be visible in Asia south of latitude 17° N. and in Australia. Con-

GENERAL CHART OF THE PLANET MARS BY P. LAMBERT
(From "La Planète Mars" Tome II)

junction (2) will be visible in South America south of latitude 11° S., while conjunction (3) will not be visible from any landed area. The latter conjunction will, however, be visible in the afternoon as a close approach from Australia.

Uranus. Uranus will be in conjunction on May 17, and in opposition November 21. The planet will be in eastern quadrature on February 11. Western quadrature will occur on August 23. The planet's apparent motion in 1941 will carry it from the constellation Aries into the constellation Taurus. The apparent motion is illustrated by Figure 5, which shows the position of Uranus among the stars for

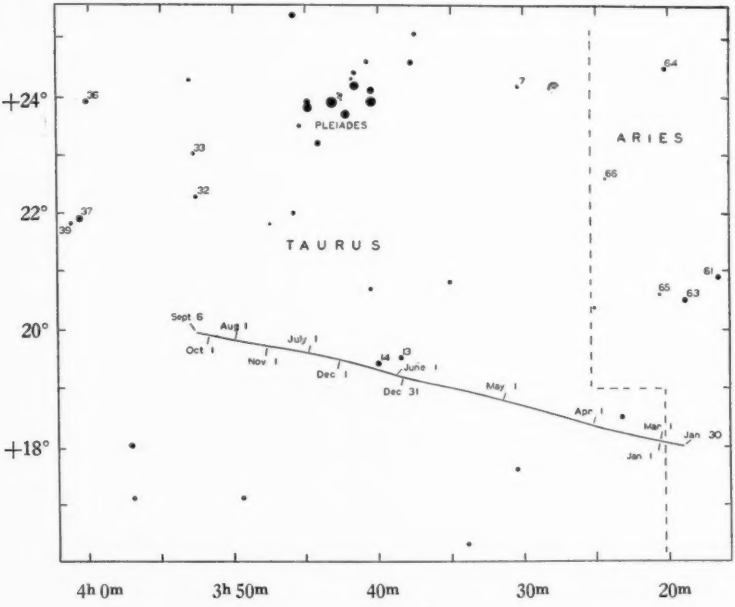

FIGURE 5
THE PATH OF URANUS AMONG THE STARS IN 1941

various dates in 1941. Examination of Figure 5 reveals that around June 10 and December 15 the planet will be located near 14 Tauri, a star of magnitude 6.3, situated about 4½° south of the Pleiades.

Neptune. Neptune will be in opposition on March 17. Conjunction will occur on September 20. Dates of eastern and western quadrature are, respectively, June 16 and December 22. Neptune will accordingly be an evening object during the spring and summer, and a morning object during the latter months of the year. The planet will be moving in the constellation Virgo, as shown in Figure 6, which illustrates the apparent path of Neptune in 1941. The star background has been plotted by means of the star positions given in the B.D. (*Bonn Durchmusterung*) star catalog, allowance being made for precession. The smallest dots represent stars of from 9.5 to 10.0 magnitude. The brightest star in the region, β Virginis, is of magnitude +3.8, and can be located in the sky with the aid of any detailed

star map such as Norton's. Figure 6 is arranged for use with an inverting telescope, and, for comparison with the field of view in the eyepiece, should be oriented so that the "up" direction points to the north celestial pole. Neptune will pass close to several faint stars in 1941, as can be verified from Figure 6.

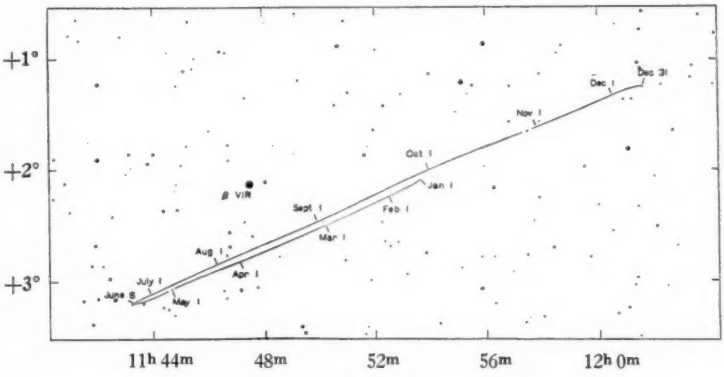

FIGURE 6
THE PATH OF NEPTUNE AMONG THE STARS IN 1941

On August 18, 0^h, a conjunction will occur between Neptune and Venus, Neptune being situated 18′ north of Venus.

An occultation of Neptune will occur December 12, the time of geocentric conjunction in right ascension being $13^h\,32^m.0$. The occultation will be observable in North and South America, between the extreme latitude limits 20° N. and 50° S.

Pluto. Pluto will be in opposition with the sun on January 24, and is located in the constellation Cancer, not far from the star λ Cancri. The stellar magnitude of Pluto is +15.0, so that a large telescope, probably one of at least 20 inches aperture, is needed for locating the planet by visual means. A chart showing the configuration of faint stars in the region of Pluto would be almost a necessity for positive identification of the planet. It does not seem worth while to prepare such a chart for POPULAR ASTRONOMY, since very few observers have access to such a large telescope.

CALENDAR OF PLANETARY PHENOMENA IN 1941

Date	Phenomenon
Jan. 3	Earth at perihelion.
Jan. 7	Occultation of Saturn. (Invisible in U.S.)
Jan. 27	Jupiter and Saturn evening stars. (Eastern quadrature)
Feb. 3	Occultation of Saturn. (Invisible in U.S.)
Feb. 11	Mercury, greatest elongation. (Evening star)
Feb. 20	Conjunction, Jupiter and Saturn. (Ang. sep. 1° 21′)
Mar. 13	Partial eclipse of the moon.
Mar. 17	Neptune at opposition.
Mar. 21	Spring begins, $0^h\,21^m$.
Mar. 25	Mercury, greatest elongation. (Morning star)
Mar. 27	Annular eclipse of the sun.
Apr. 19	Venus at superior conjunction.
May 4	Conjunction, Venus and Saturn. (Ang. sep. 1° 33′)

Date	Phenomenon
May 7	Conjunction, Mercury and Saturn. (Ang. sep. 2° 19′)
May 9	Saturn at conjunction.
May 11	Five planetary conjunctions.
May 17	Uranus at conjunction.
May 19	Jupiter at conjunction.
June 2	Mars a morning star. (Western quadrature)
June 6	Mercury, greatest elongation. (Evening star)
June 10	Close approach of Uranus to a 6.3 magn. star.
June 16	Neptune an evening object. (Eastern quadrature)
June 20	Conjunction, Mercury and Venus. (Ang. sep. 2° 54′)
June 21	Summer begins, $19^h\,34^m$.
July 3	Earth at aphelion.
July 24	Mercury, greatest elongation. (Morning star)
Aug. 18	Conjunction, Venus and Neptune. (Ang. sep. 18′)
Aug. 21	Saturn, a morning star. (Western quadrature)
Aug. 25	Occultation of Venus. (Invisible in U.S.)
Sept. 5	Partial eclipse of the moon.
Sept. 13	Jupiter, a morning star. (Western quadrature)
Sept. 23	Fall begins, $10^h\,23^m$.
Oct. 3	Mercury, greatest elongation. (Evening star)
Oct. 3	Mars closest to the earth.
Oct. 10	Mars at opposition.
Nov. 1	Occultation of Mars. (Invisible in U.S.)
Nov. 12	Mercury, greatest elongation. (Morning star)
Nov. 17	Saturn at opposition.
Nov. 21	Uranus at opposition.
Nov. 23	Venus, greatest elongation. (Evening star)
Dec. 8	Jupiter at opposition.
Dec. 12	Occultation of Neptune. (Invisible in U.S.)
Dec. 15	Close approach of Uranus to a 6.3 magn. star.
Dec. 22	Winter begins, $5^h\,45^m$.
Dec. 29	Venus, greatest brilliance. (Evening star)

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Planet Notes for February, 1941

By R. S. ZUG

NOTE: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac*.

Sun. The sun will be moving in a northeasterly direction through the constellations Capricornus and Aquarius during the month of February. Apparent positions of the sun for February 1 and February 28, respectively, are: $\alpha = 20^h\,56^m.9$, $\delta = -17°\,16'.0$; $\alpha = 22^h\,42^m.5$, $\delta = -8°\,11'.4$.

Moon. Phenomena of the moon will occur as follows:

		h	m
First Quarter	Feb. 4	11	42
Full Moon	12	0	26
Last Quarter	18	18	7
New Moon	26	3	2
Apogee	Feb. 3	2	
Perigee	14	20	

Mercury. Mercury will be an evening star during most of February. Greatest eastern elongation (18° 10′) will occur February 11, when the stellar magnitude of the planet will be —0.4. Inferior conjunction will occur on February 26.

Venus. Venus is to be found in the morning sky just before sunrise during February, but the planet will be close to the sun and rather inconspicuous.

Mars. Mars is a morning star about four hours west of the sun. The low declination (—23°) of the planet will result in its remaining inconspicuous for observers in the northern hemisphere.

Jupiter. Jupiter will be a prominent evening star during February, located in the constellation Aries. On February 20, 19^h, Jupiter and Saturn will be in conjunction, Jupiter to the north, by 1° 21′. This will be the third of a series of three conjunctions between Jupiter and Saturn.

Saturn. Saturn will be located in the constellation Aries, not far from Jupiter. An occultation of Saturn will occur February 3, visible in South America south of latitude —11°. The time of geocentric conjunction in right ascension will be February 3, 21^h 28^m. The phenomenon will be visible in North America as a close approach of the moon to Saturn. A conjunction with Jupiter will occur February 20.

Uranus. Uranus is an evening object, and will be in eastern quadrature on February 11. A chart illustrating the location of Uranus among the stars appears in this issue of POPULAR ASTRONOMY, page 34.

Neptune. Neptune is nearing opposition. A chart illustrating the position of Neptune among the stars appears in this issue of POPULAR ASTRONOMY, page 35.

Asteroid Notes

By HUGH S. RICE

Juno is in a favorable situation for observation with small telescopes, during the first few months of this year. On the evening of January 7, Juno is 1° east of the star β Sextantis, the magnitude of the asteroid being 8.6. Its course during the first two months is almost exactly northwest. On January 31, Juno is 4° northwest of β Sextantis, and the magnitude 8.4. On March 1, the planet is 3° southwest of π Leonis, and the magnitude 9.1. During March the course is northward.

The subjoined ephemeris of Juno was computed by Irving L. Meyer, of Rutherford, New Jersey, on the basis of the planet's elements as given by the Copernicus-Institut (the minor-planet headquarters), with empirical corrections to agree with their perturbation-corrected ephemeris of 1940.

Vesta is also observable, with stellar magnitude 7, and for the first week in January it is about half-way between Regulus and γ Leonis. It can therefore be picked up with a small telescope and its motion on the celestial sphere be followed for a few weeks.

EPHEMERIS OF JUNO, FOR 0^h U.T. EQUINOX 1950.

1941	α h m	δ ° ′	1941	α h m	δ ° ′
Jan. 8	10 22.0	— 0 33	Feb. 27	9 49.0	+ 5 45
18	10 18.8	+ 0 2	Mar. 9	9 42.2	+ 7 25
28	10 13.1	+ 1 3	19	9 37.5	+ 8 53
Feb. 7	10 5.6	+ 2 25	29	9 35.1	+10 6
17	9 57.2	+ 4 2	Apr. 8	9 35.3	+11 1

We have investigated the inclination to ecliptic of the 1492 asteroids whose elements have been computed; and the results reveal the following lists of the planets with least and with greatest inclination. The elements are for the equinox of 1950.

ASTEROIDS WITH SMALLEST INCLINATIONS

	Planet	Inclination		Planet	Inclination
1383	Limburgia	0°.009	20	Massalia	0°.68
1486	Marilyn	0.083	996	Hilaritas	0.687
846	Lipperta	0.244	822	Lalage	0.695
1045	Michela	0.257	300	Geraldina	0.763
637	Chrysothemis	0.318	24	Themis	0.815
1340	Yvette	0.434	1229	Tilia	0.843
551	Ortrud	0.435	1074	Beljawskya	0.867
656	Beagle	0.445	180	Garumna	0.898
468	Lina	0.492			

ASTEROIDS WITH LARGEST INCLINATIONS

	Planet	Inclination		Planet	Inclination
944	Hidalgo	42°.545	582	Olympia	30°.000
1373	1935 QN	38.881	1263	Varsavia	29.214
2	Pallas	34.818	772	Tanete	28.762
531	Zerlina	34.545	473	Nolli	27.780
1252	Celestia	33.978	1019	1924 QN	26.972
1301	Yvonne	33.920	1025	Riema	26.859
1208	Troilus	33.707	1474	1935 QY	26.766
945	Barcelona	32.819	692	Hippodamia	26.456
594	Mireille	32.667			

Hayden Planetarium, American Museum of Natural History,
New York City, December 17, 1940.

Occultation Predictions

(Taken from the *American Ephemeris*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Date 1941	Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′			h m	m	m	°	h m	m	m	°
Feb. 1	98 B.Psc	6.4	1 27.9	..	..	349	1 36.5	..	..	332
14	9 B.Vir	6.2	8 24.5	—1.1	—2.0	145	9 27.0	—1.6	—0.9	265
16	575 B.Vir	6.2	11 39.8	—1.1	—1.8	128	12 43.7	—0.9	—1.3	268
21	95 B.Sgr	5.8	8 34.8	—0.7	+1.7	78	9 39.2	—0.8	+0.7	289

		Occultations Visible in Longitude +91° 0′, Latitude +40° 0′											
Feb.	1	98	B.Psc	6.4	1	12.3	..	..	357	1	36.3	..	..	318
	2	*e*	Psc	5.7	3	42.2	—0.3	+0.1	47	4	36.9	+0.1	—1.7	281
	8	124	H¹ Ori	5.7	9	3.7	..	..	17	9	13.4	..	..	357
	10	1	Cnc	6.0	3	45.3	..	..	47	4	32.1	..	..	338
	13	*d*	Leo	5.0	12	6.2	—0.4	—1.8	127	13	1.4	—0.2	—1.3	274
	14	9	B.Vir	6.2	8	22.1	..	..	193	8	40.5	..	..	220
	16	*m*	Vir	5.2	7	34.1	—2.2	+2.3	65	8	20.9	—0.5	—2.1	345
	16	575	B.Vir	6.2	11	20.5	—1.3	—2.0	146	12	23.1	—1.8	—0.6	257
	17	6	B.Lib	6.2	6	52.9	—1.7	+3.6	51	7	25.2	+0.2	—2.5	352
		Occultations Visible in Longitude +120° 0′, Latitude +36° 0′											
Feb.	1	44	Psc	6.0	5	7.3	—0.2	—3.4	129	5	40.6	—0.1	+2.2	195
	2	*e*	Psc	5.7	3	18.7	—1.3	+0.3	56	4	33.0	—0.9	—1.1	263
	6	63	Tau	5.7	5	34.0	—1.9	+1.1	50	6	40.8	—1.1	—2.8	301
	7	111	Tau	5.1	10	42.9	..	..	164	11	0.6	..	..	202
	8	BD+18°1112		6.4	6	33.8	—2.5	+1.8	48	7	29.1	—1.0	—3.8	325
	8	124	H¹ Ori	5.7	8	31.5	—1.2	—0.7	79	9	36.7	—0.3	—2.0	298
	10	1	Cnc	6.0	2	49.6	—0.9	+2.4	61	3	49.8	—1.6	—0.8	311
	10	30	B.Cnc	6.1	11	21.7	—0.2	—2.1	134	12	14.4	—0.3	—0.9	258
	13	*d*	Leo	5.0	11	59.9	—0.4	—3.2	166	12	43.4	—1.8	—0.1	244
	16	*m*	Vir	5.2	6	59.2	—0.3	+0.5	110	8	0.6	—0.7	+0.3	294
	19	24	Sco	5.0	11	9.0	—2.2	+3.6	44	11	45.0	0.0	—2.3	344
	23	27	G.Cap	6.2	13	47.7	—1.0	+2.4	50	14	47.9	—1.0	+0.3	295

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

The attention of our members for the past few years has been frequently directed to the desirability of simultaneous work at two or more stations which would lead to meteor heights as its chief objective. The observations made for this purpose are equally valuable for radiants and statistical studies just as much as if heights were not in mind. Persons, however, who have to observe alone, no matter what the reason,—the word "alone" here means not observing simultaneously with another group or person at a distant station,—should have the determination of radiants as their chief concern. We refer naturally to those who are plotting, not merely counting hourly rates. Such persons should remember that there still remains an immensely valuable field in the accurate determination of radiants which, as yet, is largely open. Radiants have indeed been published by the thousand, but the more critically lists are examined, the less satisfactory are our findings. (I include many of those deduced by me on 3 or 4 meteors, from my own work as well as from that of others, in this criticism.)

Up to this century, a large part of the fault lay in unscientific combination of observations made over unreasonably long periods of time. Of late, this having been pointed out and generally acknowledged, if we do not get good radiants it must be due largely to lack of skill in the observers themselves, or, speaking frankly, poor plotting.

In discussing this subject further I run the risk of discouraging the observer who perforce can work only a few nights per year. This is far from my purpose and would be an unjust and unfortunate conclusion! The work of such persons is of value in very many ways, even if we can not deduce accurate radiants from it. Meteoric astronomy would suffer grievously if these persons ceased to work. And again, in time, some of these same persons will gradually acquire more skill

and then their plots can be used for this purpose also. The reason that this matter is at the moment uppermost in my mind is that I have just spent several hours projecting meteor paths on maps recently sent in. And what I find impels me to repeat some well-known facts.

First, the man, professional or amateur, who believes that meteor observing—if accurately done—is *easy*, is in great error. Having personally worked in several of the largest observatories, on a variety of programs and with great telescopes, I affirm that to plot a meteor well is as hard as any work I ever seriously undertook. This is why there are so few *excellent* meteor observers in the world, and why there is great need for some of those who are fairly or moderately good to perfect themselves. To do this, one must first learn the constellations, not merely the bright stars but those to the fourth magnitude at least. Not learn them all by name, but know the configurations so one can quickly and surely identify those stars on the map which he needs as reference points for plotting the meteor. This is not as hard a task as it might seem. Once this knowledge has been acquired, half the battle is won. From then on, assuming good eyesight, it becomes a matter of pure determination and practice: plotting like anything else needs constant doing if one is to be proficient.

Next, we know as a result of experience that a man gets more results when he can observe for a very long period on one night instead of the same number of hours during two or more nights. Here I refer to radiant determination, not rates. I further suggest that, unless a special shower is being observed, a given region of the sky centered at a certain altitude and azimuth be constantly watched. The fewer of our set of 13 meteor maps used on a given night, the easier it is to determine radiants. In fact, to transfer the projected path from one map to the adjoining one, so that the resulting track is accurate, is a troublesome matter. It becomes extremely so when the beginning point of the original plot is near one corner of the map used. As typical, plots of Perseids on our map No. 7, which includes Cygnus and adjacent regions, are practically useless for direct radiant determinations, as first one has to transfer to Map 1, and then combine what is on Map 1 with what is on Map 3, which latter has the radiant in the most favorable position on any in our set. As only a few observers do their work well enough to justify anything but graphical solutions, in the case of the Perseids we are usually able to use but a fraction of the plotted paths for radiant determination. One partial cure would be larger maps, but it is further found that radiants are best determined by paths relatively near. Errors of map projection and of plotting due to distortion—*i.e.*, all parts of the map not looking equally like the sky—are much less harmful for meteors within say 45°. In fact, to map on a plane surface, as we must, a very large section of the sky and have it look just right is impossible. As the best compromise, the A.M.S. has used the set of 13 gnomonic maps, originally calculated by Dr. R. K. Young now of David Dunlap Observatory, Canada. There are 7 other maps, also due to Dr. Young, for observers who live in the southern hemisphere. The set of 13 were carefully examined here for errors and omissions by Mrs. Doris Wills, formerly of our staff. These were furnished to Mr. E. A. Halbach, our able regional director for the Wisconsin-North Illinois group, who made new copper plates with all the corrections put in. The maps now distributed are of this new edition. There seems no reason to modify appreciably the instructions to observers in A.M.S. Bulletin No. 15. We are glad, however, to distribute to competent observers, a copy of the longer and most excellent set of instructions by Dr. P. M. Millman, who ably directs meteor work in Canada and who is one of the leading authorities any where in the subject. Photographic work, in which

he has had much success, is also discussed in his instructions. A.M.S. Bulletin No. 13, for fireballs, is still used. Its chief defect is not calling enough attention to long-enduring trains and not asking for the fullest reports on these interesting phenomena.

It seems quite certain that among our members we have some who by now have had so much experience that, with a little more, they could attain the standard set by our very few leading observers. I urge upon such persons, if their regular professions permit, that they take the necessary steps to "graduate" into the first rank. But we also need less trained observers by the score for many less technical purposes; for instance, counts for rates, as well as plotting to determine class, distribution, etc., even if not for radiants. Please therefore let even the most unskilled beginner understand that his aid is welcomed and that from the first, if only instructions are followed, what he contributes will have value. Of course, the value will be greater with more practice.

We now have many more or less active state groups. Let 1941 see a better coordination of their efforts, better work by some of the regional directors, and an active campaign for new members who will take a real interest *and work*. In passing, may I ask that the annual dues of $1.00 be sent to our headquarters at Flower Observatory without the expense and trouble of mailing out bills? This consideration would be much appreciated.

Finally, I can assure our members that efforts are being made to keep our files at headquarters in good shape and to reduce some of the mass of observations on hand as rapidly as possible. There is every reason to believe that our files here contain the largest collection of data on meteors which exists, while our library contains a good collection of books and pamphlets on the subject.

Lastly, the financial support, without which our Society could not function, is constantly supplied through the resources of the Flower Observatory, which means of course through the kind consent of the authorities of the University of Pennsylvania.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1940 December 11.

Contributions of the Society for Research on Meteorites

Edited by **FREDERICK C. LEONARD,**
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Criteria for Estimating the Population of Meteoritic Showers*

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ABSTRACT

One of the unsettled questions in meteoritics relates to the determination of the total number, N, of meteorites falling in such showers as those of Pultusk

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(Poland), Estherville (Iowa), and Holbrook (Arizona). The value of N has, for obvious reasons, not been determined by counting. Partial and unsystematic counts either have been accepted as giving the true value of N or else have been corrected by arbitrarily assuming that some specified fraction of N escaped enumeration. In the present paper, several simple criteria for estimating the population of a meteoritic shower are derived by use of the theory of probability. The formulas deduced for the determination of N have been tested with satisfactory results on man-made meteoritic showers. By the use of one of the criteria, it is shown that, for the Holbrook shower, N was almost certainly of the order of 100,000, and hence that the population of the Pultusk shower, which seems to have been a larger one even than Holbrook, probably considerably exceeded this figure. The criteria developed may be employed in many other connections.

Introduction.—Controversies such as the recent one between E. Stenz,[1] F. A. Paneth,[2] and L. J. Spencer[3] in regard to the number of meteorites which fell in the Pultusk, Poland, shower, serve to emphasize the untrustworthiness of published determinations of the total number, N, of meteorites (fragments and individuals) falling in meteoritic showers. In the case of the Pultusk shower, Stenz regards N as approximately 3,000, while Paneth, in company with almost all other authorities, accepts N as 100,000 or more. Spencer, in criticizing Paneth, states, "While it is not at all impossible or improbable that as many as 100,000 stones fell in this shower, the facts now available do not supply data for this to be proved mathematically." The value of N obviously cannot be determined simply by counting, since, under field conditions, complete discovery of the fallen meteorites is not practicable. Nevertheless, it appears to have been standard practice either to accept counts, which may or may not have been carefully and systematically made, as giving *complete* enumerations for the area covered, or else to *guess* what proportion of the stones remained undiscovered in the area searched and to correct the corresponding counts accordingly. It is the purpose of the present paper to indicate certain quite elementary methods for the more exact appraisal of N, in the hope that future investigations of meteoritic showers will be more scientifically conducted than those of the past have been.

§1. *A Criterion Based on Identical Searches.*—In what follows, we shall suppose that the area A showered with meteorites can be partitioned into k subregions R_j ($\sum_{j=1}^{k} R_j = A$), within each of which the fallen meteorites constitute a *homogeneous group*, from the viewpoint of probability of discovery, *i.e.*, a group, the members of which are equally likely to be found. The literature dealing with meteoritic showers contains many examples for which this assumption is approximately fulfilled over considerable areas R_j; *e.g.*, the prairie 4 miles west of Estherville, Iowa, whereon several thousand pieces of the Estherville mesosiderites, roughly equal in size and visibility, were found.[4] The (unknown) total number of meteorites in an admissible subregion R_j will be denoted by N_j. Evidently $N = \sum_{j=1}^{k} N_j$, so that the problem is reduced to the calculation of the probable values of the N_j.

In order to simplify the notation, we shall, in what follows, let the typical subregion R_j of A be denoted by r and the number of meteorites actually in r, by n. A criterion for the probable value of n can be obtained by the following procedure:

The region r is searched *independently* by a pair of meteorite hunters, O_1 and O_2.[5] The meteorites, n_1 in number, found by the first hunter, O_1, in r are marked in a manner not altering their visibility but are left otherwise undisturbed.[6] The meteorites, n_2 in number, subsequently found by O_2, are collected. Denote by c the number of meteorites picked up by O_2, which had been already discovered by O_1. We shall suppose that the searches of O_1 and O_2 are *identical*[7] and, in particular, are sufficiently prolonged to insure that $c \geqslant 1$.

Evidently the (empirical) probability that a particular one of the n meteorites actually in r will be found by O_i $(i = 1, 2)$ is simply

$$p_i = n_i/n.^{8} \tag{1}$$

The *expected* number of meteorites found by O_1, which are found also by O_2, is therefore

$$e_{12} = p_2 \times n_1 = (n_2/n)n_1. \tag{2}$$

Similarly, the *expected* number of meteorites found by O_2, which are found also by O_1, is

$$e_{21} = p_1 \times n_2 = (n_1/n)n_2. \tag{3}$$

The value of n which best satisfies the condition arising when we equate the common value of $e_{12} = e_{21}$ to the *observed* number, c, of common discoveries, is $(n_1 \times n_2)/c$. It is interesting to note that this value of n is precisely what we should have obtained if we had sought to minimize the χ^2-function of K. Pearson.[9] Indeed, in the present case, we find that

$$\chi^2(n) = \frac{n_2\{n_1 - (c \times n)/n_2\}^2}{c \times n} + \frac{n_1\{n_2 - (c \times n)/n_1\}^2}{c \times n}, \tag{4}$$

and that this expression, regarded as a function of the positive variable n, has a minimum for $n = (n_1 \times n_2)/c$; *i.e.*, since n is an integer, for

$$n = [(n_1 \times n_2)/c].^{10} \tag{5}$$

The fact that use of the discovery-coefficients, p_i, leads to the same value for n as Pearson's "goodness-of-fit" criterion (a point which does not seem to have been noted heretofore) throws the weight of Pearson's analysis behind the adoption of $[(n_1 \times n_2)/c]$ as the probable value of n. In view of the dependence of the discovery-coefficients on the personalities of the observers and other complex and unmeasurable psychophysical quantities (*cf.* notes 7 and 8, *post*), a penetrating mathematical discussion of the probable accuracy of (5) does not seem warranted. However, an indication of the degree of dependence to be placed on probable values of n computed by means of formula (5) can be gained from Table 1, which exhibits the results obtained from an investigation of 10 artificial meteoritic showers, in each of which 10 small stones of the Holbrook, Arizona, fall ("Holbrook peas") were thrown at random over an area r (3 ft. × 6 ft.) of a thick, closely

TABLE 1

Shower	n_1	n_2	c	n (calc.)
1	5	6	3	10
2	9	8	7	10
3	5	7	3	12
4	6	3	2	9
5	6	5	4	8
6	5	3	2	8
7	4	2	1	8
8	5	6	3	10
9	6	6	3	12
10	10	6	6	10

clipped lawn, and then made the object of 2 independent searches, as nearly identical as possible.[11]

The average of the 10 computed values of n is very close to the true value, 10. Individual values of n are as much as 20% too small or too large, so that, on the basis of this series of tests, we can conclude only that, if ν denotes a value of n computed from a single pair of searches, then the true value of n lies probably between $5\nu/6$ and $5\nu/4$. However, the upper bound, $5\nu/4$, appears to give the best approximation, for only 2 of the computed values of n in Table 1 exceed the true value, while 8 are less than or at most equal to this value, so that formula (5) seems to have a tendency to give too small values for n. A moment's reflection will explain this tendency: our assumption that all n of the meteorites are equally likely (and therefore equally unlikely) to be found is never exactly fulfilled in practice. As a result, a few of the meteorites are more easily found than their fellows and therefore are more likely to be found by *both* O_1 and O_2. As a result, the number c of *common* discoveries in practice is larger than it would be in the ideal case and the value computed for n from (5) is correspondingly too small.

As a further test of the accuracy of probable values computed by means of formula (5), the following experiment was performed: 100 peas, closely resembling the "Holbrook peas" in size, were scattered at random over an area r of approximately 16 square meters in a typical blue-grass meadow and made the objects of 2 independent, nearly identical searches. The conditions of the experiment not only made discovery more difficult than in the first test but definitely made some few "meteorites" easier to detect than the remainder, thereby favoring common discoveries. The results of this experiment were the following: $n_1 = 21$, $n_2 = 26$, $c = 7$, $\nu = [n_1 \times n_2/c] = 78$, $5\nu/4 = 98$. These results accord with the inferences drawn from the first experiment.

The preceding tests indicate that if, in the study of a meteoritic shower, the area r is so restricted as to contain a reasonably homogeneous subgroup of meteorites, then considerable confidence can be placed in the value calculated from (5) as a *lower bound* for the number n of meteorites in the subregion r. Unfortunately, a careful examination of the literature relating to meteoritic showers has failed to reveal a single instance in which the data necessary for the application of the criterion based on identical searches were secured. It is much to be hoped that in the future the necessary data will be systematically collected and published for each shower. In particular, data secured by 3 or more searches of the sort described in this section would be of considerable value (*cf.* note 5).

§2. *Criteria Based on Searches of Equal Merit.*—In order to utilize such scanty data on meteoritic showers as have been actually published, other criteria for estimating n will be developed in this section. Let us suppose now that the typical region r is subjected to two independent searches, S_1 and S_2, of *equal merit*.[12] This situation would seem to be most nearly realized either when the same observer makes both surveys or when a large group of individuals makes the first search and a second large group of the same number of individuals makes the second search, for, in the former case, no individual differences occur and, in the latter, they will tend to cancel out. As in §1, denote by n_i the number of meteorites found by the search S_i in r and suppose that the meteorites are picked up and carried away as found (as appears to be true always in practice). In this case, the second search, S_2, even if conducted as earnestly and efficiently as S_1, is unlikely to recover as many meteorites as the first search, especially if S_1 is conducted with reasonable thoroughness. In what follows, we shall, therefore, restrict attention

to those cases in which

(6) $$0 < n_2 < n_1.$$

The *empirical* probability that one of the n meteorites lying in r *before* the first search is made will be found by S_1, is $p_1 = n_1/n$. Similarly, the *empirical* probability that one of the $n - n_1$ meteorites remaining in r *after* the first search is made, will be found by S_2, is $p_2 = n_2/(n - n_1)$. Since, as time passes, fallen meteorites do not become more easily discoverable, it is unlikely that searches S_1, S_2 of equal merit will result in discovery-coefficients for which $p_2 > p_1$. In what follows, we shall, therefore, restrict attention to cases in which

(7) $$0 < p_2 = \theta p_1 \qquad (0 < \theta \leqslant 1).$$

Solution of (7) for the unknown n gives

(8) $$n = \theta \times n_1^2/(\theta n_1 - n_2).$$

Since n is necessarily positive, (8) shows that the parameter θ in (7) must actually satisfy the inequality $n_2/n_1 < \theta$.

For given n_1, n_2 the right member of (8) can easily be shown to be a decreasing function of θ. Consequently n, regarded as a function of θ on the range $n_2/n_1 < \theta \leqslant 1$, assumes its *smallest* value for $\theta = 1$. The value of n corresponding to the choice $\theta = 1$, *viz.*,

(10) $$n = [n_1^2/(n_1 - n_2)],$$

is again precisely that to which we should have been led by use of Pearson's χ^2-criterion for the case in which $p_2 = p_1$. We shall refer to (10) as giving the probable value of n based on distinct discoveries. However, the analysis just given suggests that, in general, (10) gives actually a *lower bound* for n.

The extension of the foregoing method to the case of more than 2 independent searches is immediate. For $i \geqslant 3$, we find, under assumptions analogous to those introduced before, that, in easily understandable notation,

(11) $$p_i = n_i/(n - \sum_{h=1}^{i-1} n_h).$$

Hence, equating p_i and p_k gives always a *linear* equation for the determination of n. In fact, from $p_1 = p_i$ $(i \geqslant 3)$, it follows that

(12) $$n = [n_1 \times (\sum_{h=1}^{i-1} n_h)/(n_1 - n_i)];$$

and, from $p_i = p_{i+1}$, that

(13) $$n = [n_i^2/(n_i - n_{i+1})].$$

In the future, data on meteoritic showers sufficiently complete to permit use of (12) and (13) may be collected; but the incomplete data available at present compel us to limit attention to formula (10). The dependability of this formula, as a means for computing the probable value of n, has been tested on artificial meteoritic showers in each of which 100 fragments of "iron-shale" about the size of "Holbrook peas" were scattered at random over an area r of approximately 16 square meters in a blue-grass meadow and then were made the objects of 2 searches of equal merit. The results obtained from a study of 10 such showers are given in Table 2.

The individual values of n given in this table are all too small. In fact, the average of the 10 values of n (= 58) is about 42% less than the true value. Formula (10) has, therefore, a pronounced tendency to give too small values for n. In part, this tendency may result from the manner in which θ was chosen in de-

TABLE 2

Shower	n_1	n_2	n(calc.)
1	27	7	37
2	29	13	53
3	17	10	41
4	34	16	64
5	25	18	89
6	17	13	72
7	25	13	52
8	25	14	57
9	24	15	64
10	25	12	48

ducing (10), but in part it is certainly a consequence of the fact that the more easily found meteorites are picked up during S_1. As a result, relatively too few meteorites are found during the second search, so that $n_1 - n_2$ is larger and therefore n is smaller than it should be.

§3. *Applications to Meteoritic Showers.*—In view of the great detail in which other aspects of a meteoritic shower are described, it is both surprising and disconcerting to find in the literature almost no information relating to such important quantitative features as the number of meteorite hunters who searched the shower-area; the number and duration of the various searches for shower material; and the number and size of the meteorites recovered in each search. The most detailed summary of such data known to the writer (although one which still leaves much to be desired from the viewpoint of the theory of §2) is contained in the following quotation from the paper by Foote[13] concerning the Holbrook, Arizona, fall of 1912 July 19, a shower which fell over an elliptical area, r, of dry, sandy plain, of which the surface conditions affecting recovery were quite homogeneous.

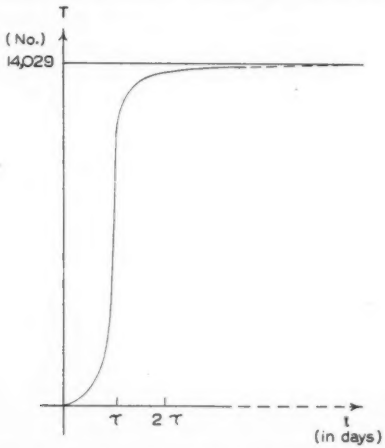
"A most careful search by over one-hundred persons was made under that stimulus which is usually found to be instantly effective. This search continued for two months. The discoveries of new stones rapidly rose and as rapidly dwindled to nothing. Following is an estimate of the entire fall. Among the 29 larger ones, three or four had an end broken off, presumably by the finder; perhaps 5 per cent of the stones, counted as complete, had one face merely smoked; the balance were completely incrusted.

"Items 1, 2, 3, and 4 were received at Philadelphia.

"(1) 29 individuals over 1000 grams: 6665, 4264, 3470, 3122, 2940, 2605, 2520, 2500, 2480, 2463, 2442, 2318, 2270, 2250, 2050, 1893, 1860, 1816, 1780, 1558, 1464, 1400, 1330, 1272, 1190, 1148, 1120, 1100, 1020 ..... Total	64,310 grams.
"(2) 6000 individuals of 1 gram to 1000 grams each	136,000 grams.
"(3) 8000 individuals under 1 gram each	4,000 grams.
"(4) Fragments broken after finding (estimated)	4,000 grams.
"(5) Many individuals of less than 1000 grams each, distributed as samples to institutions in July and carried off as curios by visitors	10,000 grams.
"14,089+ stones. Estimated total weight of fall (481⅛ lb. avd.)..	218,310 grams."

Foote's quoted statements imply that the graph of T, the total number of meteorites recovered, against the time of search t (measured in days from the moment when the intensive meteorite hunt began), has the form shown in the accompanying figure. Beyond the fact that the interval 2τ, in which the great majority of the stones were found, was small with respect to the entire duration of the hunt, we have no indication as to the numerical value of τ. However, since the point cor-

responding to $t = \tau$ on the (T, t)-graph separates an arc on which dT/dt is an increasing function of t from an arc on which this derivative is a decreasing function of t, it seems quite probable that, by the end of the τ-th day, the army of meteorite hunters had completed a first thorough search of the entire area r. Thereafter, only hunted-over ground was available and, as the graph in the figure



Graph of T, the total number of meteorites recovered from the Holbrook, Arizona, shower of 1912 July 19, against the time of search t. (2τ represents the interval in the course of which the great majority of the stones were found.)

indicates, the rate of recovery began to decrease. In what follows, we shall assume that this interpretation of the point of inflexion on the graph in the figure is the correct one. Now in view of the large number of meteorite hunters at work during at least the first 2τ days of the hunt, the small size of r, and the easy accessibility of all of its parts, τ can have been scarcely more than 6 or 8 days. Consequently, we are justified in assuming that the average number of hunters engaged during the first half of the interval 2τ was approximately the same as that during the second half and that the daily average of conditions affecting recovery of Holbrook specimens remained nearly constant throughout this interval. But, then, the group searches, S_1 (conducted during the first τ days) and S_2 (carried out during the next τ days) must have been of nearly equal merit. In spite of this fact, we cannot use all of the data secured by means of these searches in order to compute, by use of formula (10) of §2, the total population of the Holbrook shower, for this population as a whole certainly did not constitute a homogeneous group in the sense defined in §1. Thus, as was to be expected, the larger stones of the Holbrook fall were much more easily found than the smaller ones and were very speedily picked up (*cf.* Foote, *loc. cit.*,[18] pp. 437 and 441). In order to use the criterion developed in §2, we must utilize only the data relating to *homogeneous groups* secured by S_1 and S_2. Now from Foote's summary, we are able to conclude that the most homogeneous subgroup of meteorites recovered in the shower consisted of the 8,000 individuals, (3), with weights ranging between 0.1 gram and

1 gram, the so-called "Holbrook peas." We shall restrict attention to this subgroup, not only because the meteorites in it were very much alike,[14] as is evidenced by the nickname just quoted, but also because replicas of "Holbrook peas" served as the test objects in the artificial meteoritic showers discussed in §2.

All but one of the replies received by Foote from meteorite hunters to the question, "In the area covered by the fall, were the large and small stones mixed indiscriminately or were they sorted somewhat according to size?", show that stones of all sizes were spread indiscriminately over the area r. We shall, therefore, regard this entire area as the shower area for the "Holbrook peas" and the graph in the figure, with 14,029 replaced by 8,000, as representing the relationship between the total number of "peas" found and the time of search in days.

Denote by n_1 and n_2 the number of "peas" recovered in r by S_1 and S_2, respectively. Since the graphical evidence indicates that n_1 and n_2 were nearly equal and that their sum was about 8,000, we shall assume in what follows that either

(1) $n_1 = 4{,}150$, $n_2 = 3{,}650$; or (2) $n_1 = 4{,}000$, $n_2 = 3{,}800$; or
(3) $n_1 = 3{,}950$, $n_2 = 3{,}850$; or (4) $n_1 = 3{,}925$, $n_2 = 3{,}875$.[15]

Employing these numerical values, we shall compute next the probable value of n, the number of "peas" which actually fell in r, by means of formula (10) of §2. In Table 3, we give (to the nearest thousand) the values of n thus obtained.

TABLE 3

Hypothesis	n_1	n_2	n(calc.)
1	4,150	3,650	34,000
2	4,000	3,800	80,000
3	3,950	3,850	156,000
4	3,925	3,875	308,000

From the results in Table 3 and the tendency (pointed out in §2) of formula (10) to give too small values for n, it seems probable that the number of "peas" in even the Holbrook fall was of the order of 100,000. The total number of meteorites (individuals and fragments) was almost certainly of this order. Since by all accounts the Pultusk, Poland, fall was a much larger shower than the Holbrook, it would seem that the classical estimate of a population of 100,000 for the Polish fall is conservative.

As an application of formula (10) in a case where both searches S_1 and S_2 were made by the same individual, we shall calculate the probable number of australites originally lying on the surface of a certain subregion r of the Sherbrook River district in Australia. The surface of this subregion has been twice carefully searched by G. Baker.[16] During the first search, $n_1 = 83$ australites were found on the surface of r and carried away; during the second, $n_2 = 52$. Under the assumption that the searches made by Baker were of approximately equal merit, the probable number of australites originally exposed on the surface of r is found from (10), §2, to have been about 222.

It is most unfortunate that the incompleteness of available data has necessitated somewhat arbitrary assumptions at various stages of the investigations made in this section. In order that such assumptions (no matter how cogent the reasons advanced for their introduction) may not be required in subsequent applications of the theory of §§1 and 2, it is earnestly to be hoped that those fortunate enough to be permitted to investigate future meteoritic showers will be scientific enough systematically to tabulate and to publish *all* the data relative to searches and recoveries in the shower area.

REFERENCES AND NOTES

[1] Stenz, E., *Nature*, **140**, 113, 1937.
[2] Paneth, F. A., *Nature*, **140**, 504 and 809, 1937.
[3] Spencer, L. J., *Nature*, **140**, 589, 1937.
[4] Smith, J. L., *Am. Jour. Sci.*, Ser. 3, **19**, 459-63 and 495, 1880.
[5] The extension of this method to the case of more than 2 independent meteorite hunters is immediate.
[6] It is not difficult to conceive of arrangements insuring the ultimate recovery of all meteorites found by O_1 while guaranteeing the independence of the search made later by O_2.
[7] 2 searches of a region r are said to be *identical* if they are made with equal care under the same essential conditions. Among such conditions we recognize the following: that the *meteorites* originally in r should remain *unchanged* in *number* and *visibility;* that the *entire area* r should be *adequately searched* in *both cases;* that the *searches* should be of *equal duration* and made under the *same conditions* of *illumination;* that the *meteorite hunters* should have the *same acuity of vision,* the *same familiarity* with the *surface features* of *meteorites,* and the *same interest* in the *recovery* of specimens.
[8] Such a probability has been called a *discovery-coefficient* by E. Öpik, who has pointed out, in connection with the discovery of proper motions by means of the blink microscope (*Astr. Nach.*, **219**, 93, 1923), the usefulness of corresponding observations made by pairs of observers. In the present case, the discovery-coefficient for each particular observer is evidently a function of (among other things) the size of the hunted meteorites and the character of the terrain on which they lie hidden. It is for this reason that we have restricted attention to homogeneous groups.
[9] Pearson, K., *Phil. Mag.*, Ser. 5, **50**, 157-75, 1900.
[10] The symbol $[f]$ denotes the integer nearest the number f. If f is equidistant from 2 consecutive integers we shall agree to choose the larger as the value of $[f]$.
[11] These artificial showers were made and studied as follows: A frame containing a strip of 1-inch wire mesh, a yard wide and 2 yards long, was laid on the lawn and staked down so that it could be removed and then returned to the same position. With the frame in position, the meteorites were scattered at random in the squares of the mesh and their positions were recorded on a chart of the "shower" area. Where necessary, individual meteorites were then pushed out of sight in the thick grass. The frame was next removed and the first hunter, O_1, was set to work within the area r delimited by the stakes. Each meteorite found by O_1 was marked by a thin vertical wire. At the end of the first search, the frame was replaced, the finds were recorded in the proper square on the chart of the "shower" area, and the wire markers and the frame were then withdrawn. An independent search of the same "shower" was then made in the same manner by O_2. From the chart, the values of n_1, n_2, and c could then be determined. After each such determination, the meteorites were gathered up and reshowered.
[12] Two searches, S_1 and S_2, are said to be of equal merit if they are identical searches except for the fact that the number of meteorites in r at the beginning of S_2 is not the same as at the beginning of S_1.
[13] Foote, W. M., *Am. Jour. Sci.*, **184**, 437-56, 1912.
[14] The group photograph of 360 "Holbrook peas" reproduced as Fig. 2 in Foote's paper,[13] will serve to give a good idea of how closely the members of subgroup (3) resemble one another.
[15] As has already been pointed out in §2, it is quite unlikely that the second of 2 searches of equal merit will recover more meteorites than the first, particularly when (as in the case under consideration) the first search has been an unusually thorough one.
[16] Baker, G., *Proc. Roy. Soc. Victoria*, **49**, 165-77, 1936.

A Catalog of Texas Meteorites [Review]

A "Catalogue of Texas Meteorites," by Virgil E. Barnes (*Univ. of Texas Publ. No. 3945*, pp. 583-612, Figs. 96 and 97, issued June, 1940), has just (1940

Dec. 3) been received. It reports that "Seventy meteorite falls have been found within the borders of Texas, and Texas now far surpasses any other State in the Union in the number of known falls." The essence of the catalog is presented under the following subheadings: "Catalogue of Texas Meteorites and Tektites" (pp. 589-605), "Out-of-State Meteorites in Texas Collections" (pp. 605-8), and "Out-of-State Tektites in Bureau of Economic Geology Collection" (pp. 609-12). The publication is recommended to anyone interested in the meteorites of "the Lone-Star State." F.C.L.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Studies of Eclipsing Variables: An old familiar eclipsing variable, U Cephei, and two more recently discovered systems have been subjects of study by Messrs. Z. Kopal, M. Huruhata, and S. Gaposchkin at Harvard. Dr. Kopal has determined new dimensions for U Cephei. The system consists of a primary component of spectral type A0, and a secondary of G8 or K0 type. The primary is considerably smaller than the secondary and is totally eclipsed at deep minimum, as evidenced by the flatness of the light curve at this phase.

A period of $2^d.492934$ well satisfies all of the observed minima of the past twenty years, and during this interval it has been practically constant. The period used by Wendell was $2^d.492884$, shorter by $4^s.32$.

The dimensions deduced for the system of U Cephei are as follows, for the primary and secondary components, respectively:

	Primary	Secondary
Effective temperature	10,500°	4,400°
Long axis	2.6 ☉	4.2 ☉
Meridional oblateness	0.991	0.77
Equatorial oblateness	0.996	0.84
Mass	3.5 ☉	1.1 ☉
Mean density	0.22 ☉	0.04 ☉
Absolute bolometric magnitude	0.0	+3.2
Semimajor axis of related orbit	9.02×10^6 km	
Parallax	0".0039	
Distance from sun	250 parsecs	

It is concluded that U Cephei is a normal, eclipsing binary in many respects.

B.D. +60°454 is a newly discovered eclipsing binary with a period of $2^d.27436$, according to M. Huruhata and S. Gaposchkin. There is a slight possibility that the period may be half of this value. The magnitude at maximum is 10.6; at primary minimum, 11.13, and at secondary minimum, 11.10; duration of minimum, $0^d.20$. With not much evidence of ellipticity of the components, the investigators conclude that they are well separated and of the same absolute dimensions.

M. Huruhata has determined the position of the eclipsing variable SVS 877 Cygni, discovered in 1938 by Parengo, and finds that the star is not to be identified as +46°2879, but that it is situated in R.A. $20^h\ 8^m\ 14^s$ and Decl. +46° 57'.3 (1855). S. Kanda had announced a period of $115^d.323$; for an eclipsing variable to have a period of this length called for special attention.

Huruhata finds that the period of SVS 877 Cygni is really only a third of the

value published by Kanda, or $38^d.4383$. The second component, which is in the rear during the minimum, is very much brighter than the first. On the basis of the light-curve characteristics, the variable belongs to a very interesting group, in which the components differ widely in their absolute dimensions. For this system the radius of the principal component is about ten times that of the secondary. VV Cephei and Zeta Aurigae have similarly high quantitative differences between components.

The star will evidently repay, in interest, any additional observational material, both photometric and spectroscopic.

Eclipsing systems have likewise been engaging the attention of Miss H. H. Swope. In the course of her study of variable stars in the Milky Way, she has determined the light curves of four eclipsing variables in MWF 189. H.V. 10265 proves to be of exceptionally long period for an eclipsing variable, 936 days, while BN Sagittarii, WY Sagittarii, and MR Cygni have periods of $2^d.5$, $4^d.7$, and $1^d.7$, respectively.

H.V. 10265 has many similarities to the long-period, eclipsing variable, Zeta Aurigae. The duration of eclipse is $55^d.8$, and totality lasts for 51.6 days. The next observable minimum is from June 15 to August 10, 1944.

BN Sagittarii was originally discovered by Miss I. E. Woods. Zessewitsch derived a period of 5.08 days, describing the star as of the Beta Lyrae type, in respect to the unequal depths of minima. Miss Swope's investigation shows that the principal minima are of equal depth and therefore Zessewitsch's period should be halved. There is definite evidence of a shallow minimum, amounting to $0^M.07$, half way between the eclipses. There is also a suggestion of a slowly changing period, because observations made during the years 1889 to 1900, when the star was faint, do not fit the given period of $2^d.52$. The brighter component is the larger star; no ellipticity is indicated.

WY Sagittarii was discovered by Miss A. J. Cannon, and a period of $4^d.6704293$ was derived in 1931. Miss Swope's period differs very little from the originally assigned value.

MR Cygni was discovered by Wachmann. Rügemer derived a period of $1^d.676970$, and Wachmann later deduced a period of $1^d.677037$. Miss Swope derives a period of $1^d.677031$. There is a probability of a small change in period for MR Cygni, and, if this is true, the amplitude of the residuals over an interval of 29 years amounts to 0.005 of the period.

Recent Maximum of Mira Ceti: At its latest observed maximum, in July, 1940, Omicron Ceti attained a mean magnitude of 3.8. This maximum was close to expectation when it was noted that the interval between the times of attainment of magnitude 6.0 on the increase to maximum, for the maxima of 1939 and 1940, was found to be longer than the average interval of about 330 days. (See these notes, POPULAR ASTRONOMY, Vol. 48, p. 37.)

The value of maximum magnitude 3.8 for a time interval of 341 days between consecutive attainments of magnitude 6.0, on the increase to maximum, falls on the correlation curve remarkably well. Perhaps such a correlation may have reality: when this interval is long, the approaching maximum is fainter; when short, the maximum is brighter than usual.

Mira's next rise to maximum occurs at a time when the star will be involved in the sun's rays; but it will be more readily accessible for southern observers and should be watched in order that as much of the pre-maximum phase as possible may be covered.

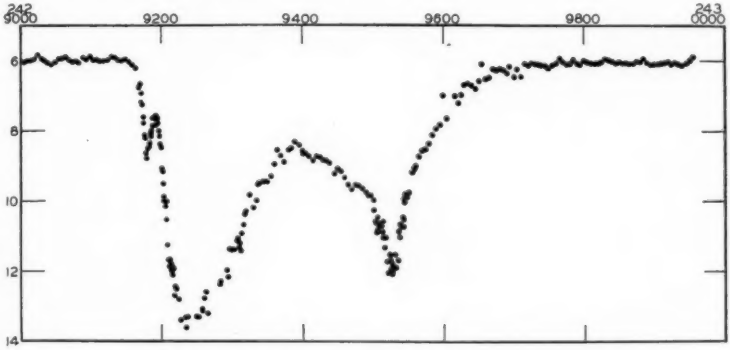
The 1938-39 Minimum of R Coronae Borealis: Now that the peculiar variable R Coronae Borealis appears to have regained its normal brightness, it is well to present the light curve both in tabular and graphical form, in order to picture what happened during the more than 600 days during which the star was fainter than normal.

In the table are given the five-day means, and the number of observations made in each five-day group, between J.D. 2429000 and 2429950. The total number of estimates included is 3570, contributed mainly by the A.A.V.S.O. Unfortunately, because of the extreme faintness of the variable and its unfavorable location for continuous observation, there is a deficiency of observations at the time of the first deep minimum. Although the table contains only five-day means, daily means covering the time when the variable was changing most rapidly have been included in the figure. This phase is indicated by the greater frequency of the plotted points.

	J.D. 2429000	9100	9200	9300	9400
0	12 6.00	18 5.88	42 8.57	3 11.40	36 8.59
5	14 6.06	21 6.02	25 9.84	3 11.13	26 8.66
10	33 6.00	26 6.00	6 11.37	11 11.19	22 8.73
15	28 6.01	23 6.02	15 11.97	6 10.77	13 8.85
20	35 5.98	12 6.03	4 12.52	7 10.11	33 8.76
25	21 5.84	33 6.00	1 12.8	4 9.83	25 8.75
30	19 5.98	49 5.94	1 13.4	2 10.20	37 8.85
35	25 6.01	42 5.95	3 13.33	11 9.99	20 8.84
40	22 6.04	37 6.01	. . .	15 9.56	16 8.89
45	23 6.12	24 6.01	. . .	32 9.45	15 9.20
50	38 6.04	15 5.98	1 13.3	12 9.42	30 9.06
55	33 5.95	20 6.03	1 13.0	9 9.28	42 9.18
60	17 5.95	23 6.16	2 13.05	11 8.96	34 9.33
65	21 5.89	49 6.23	2 12.90	30 8.55	43 9.54
70	48 6.00	29 6.64	. . .	26 8.72	15 9.65
75	22 6.06	54 7.57	. . .	31 8.90	10 9.55
80	25 6.03	41 8.24	. . .	19 8.56	36 9.59
85	18 6.05	52 8.23	1 12.3	11 8.45	50 9.65
90	14 5.95	60 7.71	1 12.0	30 8.32	35 9.74
95	21 5.99	56 7.97	2 11.80	49 8.41	23 9.82
	J.D. 2429500	9600	9700	9800	9900
0	19 10.00	1 7.0	17 6.48	21 6.06	26 6.09
5	16 10.62	3 7.33	11 6.25	19 6.04	19 6.10
10	23 10.60	. . .	7 6.48	32 6.12	14 6.07
15	29 10.77	2 7.00	8 6.05	36 6.09	12 6.06
20	33 11.70	1 7.2	24 6.15	18 6.07	4 6.02
25	18 11.71	1 7.0	19 6.08	21 6.05	16 6.09
30	7 11.79	2 6.70	28 6.11	15 5.98	9 6.04
35	4 11.08	4 6.68	14 6.16	20 6.01	4 6.10
40	20 10.68	4 6.72	10 6.17	29 6.03	5 6.14
45	26 10.01	2 6.80	19 6.18	31 6.09	2 6.20
50	34 9.69	2 6.60	27 6.23	27 6.03	2 6.00
55	32 9.20	1 6.1	26 6.16	15 6.08	2 5.90
60	12 9.01	5 6.58	32 6.09	20 6.08	
65	12 8.72	8 6.55	9 5.94	21 6.17	
70	23 8.58	6 6.23	11 6.06	26 6.10	
75	20 8.55	9 6.36	19 6.11	26 6.06	
80	32 8.38	4 6.25	16 6.11	19 6.03	
85	17 8.08	5 6.30	24 6.01	14 5.98	
90	21 7.95	9 6.39	7 6.10	12 6.07	
95	11 7.82	7 6.20	24 6.18	21 6.16	

The variable appears to have begun its descent about September 8, 1938, fallen

to magnitude 8.8 by October 8, and increased again to magnitude 7.6 on October 20. It then began a very rapid descent to magnitude 13.5, attained about November 25. From then until May 8, 1939, it slowly rose to a maximum at magnitude 8.3, after which it more slowly declined.



THE 1938-39 MINIMUM OF R CORONAE BOREALIS

A second minimum, magnitude 12.0, was reached on November 11, 1939, and then the star maintained a steady increase in light with few, if any, deviations from smoothness, until full maximum light was attained, in June, 1940. Since then the star has remained nearly constant at the sixth magnitude.

Webbs Atlas: Of interest to observers, especially to those who follow the light changes of variable stars, asteroids, and comets, is the recently issued Webbs Atlas. It contains more than a hundred separate maps of stars down to the ninth magnitude, from the North Pole to 22° south declination, all around the sky, together with a key to the individual maps.

In many instances the position of well-known variables are marked and, for some of them, the magnitudes of comparison stars in the vicinity are designated.

The Atlas is printed very clearly by the Offset Process and is well bound for convenient use. It is a book that should be included in the equipment of all variable star observers.

Observers and Observations Received during November, 1940:

Observer	Var.	Obs.	Observer	Var.	Obs.
Ahnert	37	774	Escalante	73	89
Albrecht	46	83	Fernald	138	275
Ball, A. R.	21	30	Forrester	4	4
Blunck	33	43	Griffin	42	42
de Boisblanc	2	2	Guthrie	4	4
Bouton	68	90	Halbach	86	127
Brocchi	31	44	Harris	13	13
Buckstaff	10	30	Hartmann	149	275
Campbell	2	6	Heaton	9	11
Carpenter	9	9	Hildom	4	4
Cilley	66	208	Hollis	1	1
Cooke	13	22	Houston	15	18
Cousins	28	100	Howarth	15	15
Diamantopolous	11	45	Irland	13	19
Diedrich	10	10	Jones	50	107

Observer	Var.	Obs.	Observer	Var.	Obs.
Kanda	3	27	Prinslow	5	5
Kearons	74	147	Purdy	8	8
Kelly	8	16	Roe	7	7
Knott	10	10	Rosebrugh	17	112
de Kock	62	243	Ryder	17	17
Kotsakis	8	82	Saxon	30	40
Koutz	51	62	Schoenke	8	8
Livingston	33	43	Sill	57	57
Lovinus	10	10	Smart	2	2
Maupome	34	40	Smith, F. P.	17	18
McKeon	1	1	Stahr	3	3
Moore	17	17	Topham	145	145
Nadeau	18	26	Townsend	12	12
Neale	6	6	Walton	18	38
Parker	19	23	Webb	43	44
Peltier	90	179	Yamasaki	41	41
Plakidis	12	19			
			63 Totals		4061

Comet Notes

By G. VAN BIESBROECK

The daily press has created a great deal of interest in the brightening up of COMET CUNNINGHAM. Estimations of brightness in the course of last month have shown that naked-eye visibility has started in the early days of December. Moonlight, however, has interfered since, but after the middle of December the comet will be visible again on a black sky. It should become a conspicuous object by the end of December and reach nearly first magnitude shortly after the turn of the year. The position can be found from the ephemeris given on p. 552 of the December issue. This was based on the following elements computed by the discoverer, L. E. Cunningham, from early observations covering an interval of about six weeks:

Time of perihelion	1941 Jan. 16.25204
Perihelion to node	199° 35′5
Longitude of node	295 42.2
Inclination	49 51.8
Perihelion distance	0.3682175 astronomical units

The fact that this parabolic orbit holds well so far means that the comet describes a very large orbit and that its period probably runs into many centuries. Not until all the observational material is discussed will it be possible to tell something more precise about this.

The little star chart herewith shows the position of the comet at intervals of four days, each cross referring to the location at 6:00 P.M., Central Standard Time, of the corresponding date. The chart will help in naked-eye estimations of the total brightness. Altair, α Aquila, will make a good reference point in locating the region which is observable immediately after sunset.

The tail of the comet has developed in size and brightness along with the increase in brightness as the comet approaches both earth and sun. Aside from this, the general appearance does so far not differ from Fig. 2 on p. 552; the tail remains short compared with the size of the head and it shows hardly any fine structure. Early in January, however, the tail will certainly reach several degrees in length and probably take on the shape of a paraboloid envelope around the bright stellar nucleus. But the comet will be visible only for a short time after sunset

and by the middle of January it will be too close to the sun for further observations, thus terminating visibility as far as observers on this side of the equator are concerned. After that the object should become conspicuous for southern observers, fading, however, soon as its distance begins to increase.

PATH OF COMET CUNNINGHAM,
December 28 to January 13

No other comets are known to be visible at this time. COMET OKABAYASI has apparently not been observed after November 3. The author was unable to locate it visually with the 40-inch refractor on December 5. There is still a possibility that photographic observations may reveal its presence before it finally is lost as its distances from the earth and the sun increase.

Williams Bay, Wisconsin, December 10, 1940.

Notes from Amateurs

The Star Party, Evanston, Illinois, July 30, 1940

The 1939 Cleveland "Star Party" was attended by Dr. David W. Russell, of the National School of Education and faculty of Northwestern University, both in Evanston, Illinois. He was so impressed with the popular interest in astronomy that he resolved to try the plan in Evanston. He determined to put on a "Star Party" there that would sweep the town. Dr. Russell had a little difficulty at first locating amateur telescope makers, but, once this was done, the information passed from one to another until he had no difficulty in getting as many as needed. He next "sold" the Evanston *Daily News-Index* the idea. The paper agreed to back him to the limit, as this stunt had never before been attempted in Evanston.

The date was set. Marion Shell of the *News-Index* did a grand job with the

publicity. Dr. Russell arranged to have the large observatory of Northwestern University open all evening to any and all who wished to look. Mr. E. P. Martz, famous for his studies of the planets, and Dr. Charles Hetzler, of the observatory staff, were in charge. Dr. Russell asked and obtained the splendid coöperation of Dr. Oliver J. Lee, director of the observatory, who did all in his power to make the party a grand success.

At last, the day arrived. It dawned cloudy. It stayed cloudy. Thunder storms hovered out over the lake. Heavy clouds passed and repassed all day. At sundown all was discouragement. The amateurs arrived with their telescopes and set them up. One group of five or six was arranged on the lawn on each side of the observatory building. People arrived singly, in pairs, and then in groups as darkness approached. Still too cloudy! We surely thought then that our long preparations had gone for naught.

Dr. Russell was fortunate to have been able to get Mr. J. Stanley McIntosh, Professor of Visual Education at Northwestern University, to come out and bring some astronomical movies. He set up his movie machine on the lawn and rigged up a screen on some bushes. His pictures were a God-send. He showed some remarkable astronomical movies, and one Mickey Mouse comedy. Strange to say, this film got the biggest hand. It kept the crowd happy while the rest of us were arranging to have the clouds dissolved some way.

About a half hour after dark, the sky suddenly cleared. The stars burst out. We really went to work then. The writer took group after group out on the campus and, with a powerful flashlight, pointed out the constellations and talked about them. Then the group would go in a body to the amateurs with their telescopes. After taking a look, they would move on to the big refractor in the dome and listen to Mr. Martz or Dr. Hetzler explain the mysteries of the heavens. More listened to the talks over the sound system we installed on the roof of the observatory. Nearly 1500 people passed by that night. For a city the size of Evanston, Illinois, with the publicity of the *Daily News-Index* alone, we thought the party was a huge success. We were there until well after midnight before the last guest had departed.

Credit should be given also to Clarence R. Smith, instructor of physics at Aurora College, Aurora, Illinois. Mr. Smith demonstrated the practical ability of telescopes made by amateurs from home-made parts. The help of George H. Olewin, of the physics department of Northwestern University, should be acknowledged also for his demonstrations during the evening.

Dr. Russell did a very fine job of the "Star Party" in Evanston, and I am reporting this in connection with the Cleveland* "Star Party," with a hope that it will stimulate interest in this subject to such an exent that other people will take up the idea in other cities, until each succeeding summer will have a series of popular "Star Parties" put on in numerous cities about the country.

JAMES L. RUSSELL.

*See preceding issue, page 566.

General Notes

Mr. James Stokley, of *Science Service,* gave an address at the Cosmos Club, Washington, D. C., on Monday, December 9, 1940. The subject of the address was "Roaming the Heavens."

Ruth Elaine Bailey, widow of Solon I. Bailey, well-known astronomer at Harvard College Observatory, up to the time of his death in 1931, died on November 28 after a long illness. She was in her eighty-third year.

The Rittenhouse Astronomical Society of Philadelphia held its regular monthly meeting on Friday, December 13, at the Franklin Institute. Two of the past presidents of the Society, Dr. John H. Pitman, of Swarthmore College, and Dr. Henry V. Gummere, of Haverford College, presented papers on the causes and consequences of the precession of the equinoxes.

The Yakima Amateur Astronomers of Yakima, Washington, held their fourth annual banquet on December 10. Two educational films entitled "The Sky" and "A Trip to the Moon" were shown as part of the program. Officers for the coming year were elected.

Observation of the Solar Eclipse of October 1, 1940

Mr. Herbert Luft has sent a report on observations of the eclipse made by him at Sao Paulo, Brazil. At maximum phase, somewhat less than half of the sun was in eclipse. His observations give the time of first contact as $7^h\,54^m\,55^s \pm 2$ sec., and of the last contact as $10^h\,01^m\,15^s \pm 0.5$ sec. (in Standard Time at Rio de Janeiro, which is three hours west of Greenwich). Mr. Luft also attempted some photometric observations but without complete success. His observations show a slight variation in temperature but practically no variation in barometric pressure during the period of the partial eclipse.

A Neighborhood Meeting at the Yerkes Observatory

The first of a new series of middle-western neighborhood meetings took place at the Yerkes Observatory on November 23, with thirty-eight astronomers in attendance. It was agreed that approximately three similar meetings should be held each year at Yerkes, Dearborn, and Washburn Observatories. Dr. Jesse Greenstein will act as secretary. The meetings are intended for the discussion of current research problems and for the informal exchange of opinions among astronomers of different institutions. The Yerkes meeting was devoted to problems of interstellar absorption. Dr. A. E. Whitford, of the Washburn Observatory, spoke on "Spectrophotometry of Stars and Nebulae." Dr. Joel Stebbins spoke on "Selective Absorption toward the Poles of the Galaxy," and Dr. R. H. Baker, of the University of Illinois, presented his latest results on "Star Counts in Auriga." Informal remarks were made by Dr. W. W. Morgan on the spectroscopic basis of determinations of stellar color-excesses, by Dr. Jesse Greenstein on the present status of the interpretation of observational data dealing with absorbing clouds in space, and by Dr. James Cuffey on the use of open clusters for a search of relatively transparent regions in space.

The geographical limits of the area represented at the meeting is described by the names of some of those who were present: W. J. Luyten (University of Minnesota), F. E. Edmondson (University of Indiana), R. H. Baker (University of Illinois), W. A. Calder (Knox College), C. C. Wylie (University of Iowa). O.S.

The Exchange of Astronomical Publications during the War

One of the effects of the present war is the virtual isolation of all astronomers in continental Europe. Because of the breakdown in communications most European observatories are no longer receiving regularly astronomical publications

from the United States. Publications from continental Europe are conversely no longer reaching us. Second-class mail does still go through, but the risk of loss in passage is so great that it would be a mistake to continue all mailings to Europe as in times of peace. Dr. Oort of Holland has written that this lack of current publications is felt as a hardship by our colleagues abroad and he has requested that some way be found to send at least one copy of each publication to Holland for circulation among the astronomers in this country.

The case of Holland is not unique, and at the Wellesley meeting of the American Astronomical Society the Council appointed a committee to promote the continued distribution of American astronomical literature abroad. This committee is getting in touch with astronomers in continental Europe, and with the aid of postal authorities it is investigating the best ways for the mailing of current publications. If the first experimental mailings to Holland are successful the committee hopes to work out a scheme by which one copy of each new astronomical publication is sent to an astronomer representing a single country or group of countries abroad, who accepts the responsibility of circulating each item received among his colleagues. The committee wishes to offer this service immediately to Holland (1 copy), France and Belgium (2), Germany (including former Austria, Czechoslovakia, and perhaps Poland) (3), Scandinavia (1), and Italy (1). In return the committee hopes to receive from abroad a few copies of current publications for circulation among astronomers of the United States.

The committee will be glad to advise every astronomer, confronted with the problem of mailing an observatory publication, about what appears to be the safest procedure. The names of the various "circulation managers" abroad will be made available upon request as soon as these men have expressed their willingness to serve in this capacity.

The committee wishes to ask the astronomers of the United States for help in supporting the work. The editors of the various journals can hardly be expected to donate eight copies of each edition free of charge. The funds for subscriptions to Holland have already been obtained and it is hoped that further aid will be forthcoming. Special small gifts to help defray the costs of mailing will be needed if the committee is to carry out its plan successfully.

The committee will at first limit its activities to the mailing of a few current numbers of the leading astronomical journals published in the United States. If this goes well, it will attempt to add to its mailings some journals and observatory publications from Great Britain and Canada.

B. J. Bok, *Chairman*, H. R. Morgan, J. Stokley.

December 15, 1940.